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PROTECTION OF BIRDS IN BRITAIN

IN Great Britain there are two main sets of laws dealing with the protection of birds—the Game Acts and the Wild Birds Protection Acts.

In contrast to some other European countries, where game birds may include thrushes, skylarks and even grebes, game birds in England and Wales are strictly defined in the main Game Act of 1831, which designates black game, bustard, grouse, partridge and pheasant under this heading, and lays down the close times which are to be observed for these species. In addition, game birds are also subject to strict controls regarding sale, possession, trespass and so on, and can only be shot by those possessing a game certificate, whereas for wild birds a gun licence only is necessary. Duck, geese and waders, although shot for sport, are not designated as game and are covered by the Wild Birds Protection Acts. Woodcock, snipe, quail and landrail, though not designated as game in the Act of 1831, and the close times of which are regulated by the Wild Birds Protection Acts, are, however, included in some of the provisions of the Game Acts, and it is necessary to possess a game certificate to shoot them.

The Wild Birds Protection Act of 1880 superseded all previous Acts for the general protection of birds and formed the main basis of legislation. In the ensuing fifty years, thirteen further Acts for the protection of birds were made law; further, in the course of time, 250 local orders have been added making various alterations regarding close times, etc. The Acts of Parliament have to be read together with the local order to ascertain what amount of protection any particular bird may have—and, in short, the law is so complicated and unwieldy that few people understand it, much less enforce it.

The need for new legislation has been recognized for nearly half a century. So long ago as 1914, a departmental committee was appointed by the Home Secretary under the chairmanship of the Right Hon. E. S. Montagu, M.P., to make recommendations for clearing up the confusion of the bird protection laws. This committee made its report in 1919; but since that date, six further Acts have been passed. Various societies and individuals have sought to introduce new measures to end the existing state of confusion, and committee after committee of ornithologists and other experts have spent much time and trouble in drawing up reports to this end. But the years have passed without any result from their labours.

After the War the Home Office Wild Birds Advisory Committee was reconstituted under the chairmanship of the Earl of Ilchester and continued the work of preparing a single Bill for the Protection of Birds, which would incorporate and simplify all necessary provisions contained in existing legislation with the addition of further provisions to meet modern requirements. Concurrently, a Scottish Wild Birds Advisory Committee worked on the same lines, and the agreed proposals of the two Committees form the main provisions of two Bills placed before Parlia-

ment, one in the House of Lords, sponsored by Viscount Templewood, which received its second reading on November 11, 1953, and a private member's Bill in the Commons, sponsored by Lady Tweedsmuir, which received its second reading on December 4, 1953.

Under both these Bills, no less than fifteen complete Acts of Parliament and also parts of several more are repealed, which gives some idea of the much greater simplification and clarity which should result.

The two Bills, being based on the proposals made by the Advisory Committees, are very similar and only vary in certain details. The fundamental provision is the change to the modern conception of affording protection throughout the whole year to all birds, excepting those causing damage, which may be killed at any time, and also those which are termed 'sporting birds' and may be killed during certain periods of the year only. The principle of departing from the old system of making long lists of birds which are to receive protection has already been adopted by other countries, notably by Northern Ireland in 1931, and forms the basis of the International Convention for the Protection of Birds which was signed *ad referendum* by the representatives of twelve European countries in Paris in 1950 (*Nature*, **167**, 173; 1951). Under the old system, if a rare bird appeared in Great Britain it was not legally protected unless it happened to be mentioned in a list, either statutory or local; but under the new provision all rarities will be automatically provided for under the omnibus protection accorded to all birds.

Four schedules are added to the Bills. The first contains the very rare species, the killing or taking of which at any time is subjected to increased penalties. A second part of this same schedule contains a list of species considered as sporting birds but which, though not uncommon, rarely breed in Great Britain. They are, therefore, during the breeding season, given the additional safeguard of increased penalties, though they may legitimately be killed at other times. The special penalties also apply to the taking of eggs of all birds in this schedule. The second schedule contains a list of birds which are considered harmful in one way or another and which may be killed at any time. In order to avoid the wholesale destruction of such birds, the power to destroy them is limited to owners and occupiers of land, and certain statutory bodies, or persons authorized by them. The third schedule contains a list of the sporting birds which may be shot outside a specified close season, and the fourth schedule consists of birds which may not be sold alive, unless they are close-ringed specimens bred in captivity. This last schedule is a re-enactment of the Bird Protection Act 1933, which was designed to stop the traffic in British wild birds.

In the past, legislation with regard to bird protection has proved far too inelastic, and with rapidly changing conditions this state of affairs is unworkable. A common species may become scarce; or a species which is quite innocuous in small numbers may become the reverse if there is a large increase. In the present Bills, allowance is made for such changes by investing the Secretary of State with the power to make any necessary adjustments to the schedules. Exceptions to the provisions of the Bills may also be made, by means of licences, for science, education and so on; and agriculture, fisheries and other interests are safeguarded. Statutory committees on wild birds to advise the Secretaries of State for England and Scotland are to be appointed.

In the past, certain methods of taking and killing birds have been prohibited, mainly on account of the cruelty involved, and these prohibitions have been incorporated in the Bills. To these have been added certain other methods which are prohibited, not so much on account of any cruelty involved, but to avoid undue slaughter of birds in large numbers and to make the odds brought about by modern methods of destruction less heavy against the quarry.

The need for an international point of view in bird protection is now generally recognized, and this is provided for in the new Bills by restrictions on the import of certain birds and eggs, and power is given to the Secretary of State to prohibit the import of any bird or egg for the whole or part of a year. In this way international co-operation with any country which is endeavouring to prevent the exploitation of any species can be achieved; a precedent for this was made in the Protection of Quails Act, 1937, which prohibited the import of live quails during certain months, a measure in support of the action taken by the Egyptian Government in prohibiting the export during the same period.

It is generally accepted that the commercialization of a species is its greatest danger, and to this end restrictions are placed on the sale of certain birds, alive or dead, and the sale of eggs of birds which have nested in the British Isles (those of certain gulls only excepted).

The question of the protection of wild birds' eggs is one of great difficulty. In the International Convention for the Protection of Birds, the general policy of according the same protection to eggs as to birds themselves is followed, subject to certain exceptions, and this method has been adopted with success in other countries, including Australia. The Wild Birds Advisory Committee, on the whole, also took this view; but a very decided opposite opinion has been voiced by many people, including the Government spokesmen, the contention being that it is highly undesirable to create a criminal offence in a young boy taking a common bird's egg. That this state of affairs already exists in a large number of counties, in some of which practically every British nesting bird's egg is protected by county order, does not alter this view. This difficult question has been dealt with in different ways in the two Houses; in the House of Lords' Bill, only eggs of the rare birds (Schedule 1) are protected by statute, but power is given to the Secretary of State to prohibit by Order, affecting the whole or part of Great Britain, the taking or destruction of the eggs of any wild bird specified. This maintains the present situation so far as eggs are concerned, and retains the long local lists which it is so desirable to eliminate.

In the Commons, the other approach has been taken of according protection to the eggs of all wild birds except for those of the harmful birds (Schedule 2) or "of any other common wild birds which the Secretary of State may by Order made with respect to the whole or any specified part of Great Britain prescribe for the purposes of this paragraph". This again is not a simple solution, for a list of birds' eggs which may be taken is, in the opinion of some people, a direct incentive to plunder birds' nests; moreover, to draw up such a list would be a far from easy task.

In the Bills, power to establish bird sanctuaries is given to provide for such areas which are not covered by the National Parks Act of 1949, enforcement of the law is made simpler and penalties for infringement are increased in accordance with present-day standards.

The Game Laws are in no way affected by the Bills except in so far as they mention the landrail and quail. These two species, having become very scarce, are included in the first schedule of the new Bills; the relevant passages regarding the shooting of these birds in the Game Acts 1831, 1832 and 1860 are therefore repealed.

Legislation in Great Britain for the protection of birds, as has been said, has become involved and cumbersome, and a revision was overdue. The present Bills, while not wholly satisfactory, seem to provide, in their different ways, for the protection of birds, and are in line with international feeling on the subject; it is to be hoped that there will be no undue delay in one or other reaching the Statute Book.

THE CASE FOR NATURAL SELECTION

Evolution in Action

Based on the Patten Foundation Lectures delivered at Indiana University in 1951. By Dr. Julian Huxley. Pp. 160. (London: Chatto and Windus, 1953.) 9*s*. 6*d*. net.

IN a very short time biologists, all over the world, will celebrate the centenary of "The Origin of Species by means of Natural Selection". There may be some heart-searching; there will certainly be a great deal of discussion.

Darwinian orthodoxy demands implicit faith in the efficacy of natural selection operating on chance mutations. Subscribe to this and all doubts and hesitations disappear; question it and be forever lost. The case for orthodoxy can seldom have been stated with greater cogency and enthusiasm than by Dr. Julian Huxley in "Evolution in Action". A few readers, perhaps rather pagan in their outlook, may think it a little strange that, if the case is quite so strong as they are asked to believe, it should still be necessary to argue the merits of natural selection with almost evangelistic vigour.

On one point all biologists are agreed: the basic concept of organic evolution has, for a century, stood unrivalled as a contribution to biological thought. As a working hypothesis it opened up and exploited vast new fields of palæontological, anatomical and embryological inquiry. The status of natural selection is not quite so high. True, it is the only theory we have; but when judged as a working hypothesis it is disappointing to find so little advance in a hundred years. What new facts have been brought to light? How far can it be shown to have elaborated the pageantry of animal life since 1859? A century is a fantastically short period of cosmic time, and all sorts of queer, exciting and improbable things may happen in five hundred million years; so, if we accept 'possibility' as a basis for scientific thought, why worry? Dr. Huxley admits quite frankly: "No one would bet on anything so improbable happening; and yet it *has* happened. It has happened thanks to the workings of Natural Selection and the properties of living substance which make Natural Selection inevitable". What more can be said, except possibly to suggest that there may be a slight difference between something that 'has happened' and one which 'may have happened'. No amount of argument, or clever epigram, can disguise the inherent improbability of orthodox theory; but most biologists feel it is better to think in terms of improbable events than not to think at all; there will always be a few who feel in their bones a sneaking sympathy with Samuel Butler's scepticism: " . . . there must have been a little cheating somewhere with these accidental variations [mutations] before the eagle could have become so great a winner". How far the heathen will be converted by Dr. Huxley is difficult to say.

The theory of natural selection implies the survival of organisms possessing functional advantages over their predecessors or rivals. Strange as it may seem, one immediate effect of the "Origin" was a marked recession in the study of animal function. There was, and still is, a tendency for morphologists to ascribe to organs and structures functional significance for which there was, or is, little observational evidence. In this respect "Evolution in Action" is by no means guiltless; it goes a considerable way beyond the physiological facts. Is Dr. Huxley quite sure that the loss of the lateral digits by the ancestors of the horse gave them an "additional turn of speed"? And, is he certain that the parallel between increasing complexity of anatomical structure (so clearly displayed throughout vertebrate evolution) and increasing complexity or versatility of behaviour is quite so obvious as he suggests? In what ways is the behaviour of a frog, a lizard, or even a sheep, an 'advance' on that of a stickleback? What about the hoary old story of snakes walking by their ribs?

To lay readers the more exciting part of "Evolution in Action" deals with the position of man in relationship to the rest of the animal world. To Dr. Huxley, man is an organism in a class apart from all others. In many ways man is more distinguished; but most readers will be sorry to read that "the human species to-day is burdened with many more deleterious mutant genes than can possibly exist in any species of wild creature". It seems a great pity that natural selection should have met its Waterloo just when it was most needed.

In the jungles of the past Nature guards her secrets with particular care, and it is a brave man who ventures far from the recognized tracks; it is so much easier to sit and criticize more adventurous spirits. Dr. Huxley's aim is not to comfort the despondent but to hit the dragons of Improbability stoutly on the nose and to give the world "a real feeling of the unity and sweep of evolution . . . as a self-transforming process . . . building its future by transcending its past". He has succeeded.

J. GRAY

CARBOHYDRATE CHEMISTRY

Advances in Carbohydrate Chemistry

Edited by Claude S. Hudson, Melville L. Wolfrom, Sidney M. Cantor. Vol. 7. Pp. ix+370. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1952.) 7.50 dollars.

SINCE the first volume of "Advances in Carbohydrate Chemistry" was published in 1945, this series has established itself as indispensable both to those who work in this field and to those workers in other fields who wish to be well informed about sugar chemistry. The present volume maintains the high standard set by earlier volumes of the series. It contains eight articles, five from Britain, two from the United States and one from Germany.

The first of the articles, "The Methyl Ethers of the Aldopentoses and of Rhamnose and Fucose", contributed by R. A. Laidlaw and (the late) E. G. V. Percival, continues the series on the methyl ethers of the sugars started in earlier volumes. Methylation remains the backbone of structural studies in carbohydrate chemistry; this authoritative article will be of particular interest to those engaged in structural studies of the naturally occurring pentosans and of plant gums and mucilages.

The second article, "1,6-Anhydrohexofuranoses, a New Class of Hexosans", by R. J. Dimler, concerns two compounds, D-glucosan $<1,4>\beta<1,6>$ and D-galactosan $<1,4>\alpha<1,6>$, which are of considerable interest in that they contain a 1,2-glycol system which is not attacked by sodium metaperiodate. This observation is important in view of the widespread use of and increasing dependence on this reagent to detect 1,2-glycol systems; but I am inclined to the opinion that the article would have been more valuable had it been delayed until work designed to test some of the theories advanced to explain this resistance to oxidation had been completed.

The next two articles concern the ketoses. C. P. Barry and J. Honeyman review "Fructose and its Derivatives", and J. V. Karabinos reviews "Psicose, Sorbose and Tagatose". Both articles give excellent accounts of their subjects, although the addition of a discussion of the fructose phosphates, especially of fructose 1,6-diphosphate, would have been welcome in view of their biochemical importance. No mention is made of the tagatose 6-phosphate described towards the end of 1949 by Totton and Lardy[1]. Since Dr. Karabinos's review contains only two references (probably added in proof) to papers appearing at a date later than 1949, it is probable that this publication of Totton and Lardy appeared after the review was completed. If this is so, then the delay between the completion of the article and its publication is considerable and strengthens my opinion that all articles of this type should bear the date of receipt of the manuscript by the editors.

The fifth article, "Acetals and Ketals of the Tetritols, Pentitols and Hexitols", by S. A. Barker and E. J. Bourne, is a valuable account of the preparation and properties of these compounds and includes an interesting discussion of the most probable manner in which a given carbonyl compound would condense with a given polyhydric alcohol. The sixth article, "The Glycals", by B. Helferich, has been translated by W. Pigman from the original German. The unsaturated sugar derivatives are not as widely known as they might be, and it is to be hoped that this article on glycals will be followed fairly soon by one on the glycoseens. "The Chemistry of the 2-Amino Sugars (2-Amino-2-Deoxy-Sugars)" is discussed by A. B. Foster and M. Stacey. Members of this group of compounds are of considerable interest, both intrinsically and as structural components of the mucopolysaccharides.

All these seven articles in the volume give long and apparently exhaustive tables of selected physical constants of derivatives of the compounds under review.

The final article, "The Size and Shape of some Polysaccharide Molecules", by C. T. Greenwood, reviews the application of physical methods to the determination of the molecular weights of polysaccharides other than starch and cellulose and shows the importance of the use of all possible methods of study before hazarding any suggestion as to the structure of any polysaccharide. In this article I found that the editorial policy of the use of expressions of the type $(0{\cdot}7)10^6$ and $0{\cdot}7(10)^6$ in place of the more familiar $0{\cdot}7 \times 10^6$ was at first confusing and later irritating.

The articles as a whole are well written. The printing is clear and the paper and binding excellent. A few trivial misprints were noted, among which were four cases of the value for the diffusion constant (D) in the last article being given in terms of 10^7 instead of 10^{-7}. The volume contains comprehensive author and subject indexes; the entries in the latter were compiled using the recently adopted rules of carbohydrate nomenclature[2], but the articles to which they refer were written before these rules came into force. There is, however, no confusion.

To sum up, the volume is a valuable contribution to the literature and should be in the possession of all who are interested in carbohydrate chemistry.

L. J. HAYNES

[1] Totton, E. L., and Lardy, H. A., *J. Biol. Chem.*, **181**, 701 (1949).
[2] *J. Chem. Soc.*, 5108 (1952).

CHEMICAL TECHNOLOGY

Encyclopedia of Chemical Technology

Edited by Raymond E. Kirk and Donald F. Othmer. Vol. 4. Cineole to Dextrose; pp. xvi+969. (1949.) Vol. 5, Di- to Explosions; pp. xvi+992. (1950.) Vol. 6, Explosives to Furfural; pp. xvi+1008. (1951.) Vol. 7, Furnaces to Iolite; pp. xvi+982. (1951.) Vol. 8, Ion Exchange to Metal Plating; pp. xvi+944. (1952.) Vol. 9, Metal Surface Treatment to Penicillin; pp. xvi+944. (1952.) Vol. 10, Pentacene to Polymethine Dyes; pp. xvi+976. (1953.) (New York and London: Interscience Publishers, Inc.) 25 dollars or £8 15*s*. each volume.

A HUNDRED years ago, the chief source of information bearing on chemical technology was Dr. Ure's "Dictionary of Arts, Manufactures and Mines". At the turn of the century Watt's "Dictionary of Chemistry" was available, but for general reference there was not much else. Thorpe's "Dictionary of Applied Chemistry" and Ullmann's "Enzyklopädie der Technischen Chemie" came into use later. The first volume of Thorpe's "Dictionary" had, however, appeared in 1890.

Turning over the pages of Kirk and Othmer's "Encyclopedia of Chemical Technology", of which Vols. 1–10 have now appeared, the tremendous progress of chemical technology during the past fifty

years is strikingly demonstrated. Already there are ten thousand pages up to the letter P, and more is yet to come. The subjects included in this encyclopædia confirm the statement which is often made that chemistry nourishes the growth of all technology. One only needs to cite at random a few of the headings to separate articles to illustrate this statement—lubrication, furnaces, malaria chemotherapy, metallic coatings, lamp manufacture, eggs. There are, of course, many articles relating to the different branches of chemical industry—fuels, glass, fermentation, explosives and so on. Articles also are to be found on the techniques—instrumentation, electronics, gas analysis, mass spectroscopy and many other such subjects. The various processes proper to chemical engineering—drying, distillation, crystallization, mixing—are treated in an up-to-date way with suitable photographs and diagrams of plant. There will be found articles on different physical and physical-chemical subjects, such as heat transfer, diffusion, dialysis, electrochemistry, etc., which underlie chemical processes and chemical engineering methods. Besides all this, information is provided about individual chemical substances (organic and inorganic), their properties, their use, their methods of preparation or manufacture and the economic aspects relating to their supply. Pharmaceutical products, biochemical preparations, dyes and intermediates (more than a hundred pages), etc., are included. The article dealing with cosmetics, because of the wide variety of products, is even larger than that on iron; the section of the latter dealing with the blast furnace is perhaps rather too compressed, considering the scale of production with which the blast furnace is concerned. By the careful cross-referencing and the grouping of classes of compounds together, for example, hydrocarbons, petroleum products, cyanides, etc., it has been possible for the editors to provide much information without too much repetition and elaboration.

The articles are written by specialists, and the editors have taken trouble to maintain as uniform a treatment as possible and a high standard. Each article is followed by a brief bibliography. The presentation and printing are pleasing. Most of the contributors are working in the United States; many are widely known for their work throughout the world. The information collected in these volumes is a record of the state of chemical technology in the New World rather than the Old, and this is exemplified on turning up the sections on gas—natural gas, manufactured gas and carbonization: manufactured gas has greater relative importance in Britain than in America, and the technology is somewhat different.

The proportion of the world's trade in chemicals at the present time is nearly as great in the United States as in the whole of the rest of the world, and the turnover has increased at a much greater rate in recent years than in Britain; the rate of increase is greater also in Switzerland. The installation of refineries in Britain and development of other processes may help to widen the basis of chemical industry in this country. Nevertheless, it is comforting that penicillin, polythene and paludrin, to mention three new products under the letter 'P' alone, have their origin in British laboratories.

There are useful articles on such subjects as literature, nomenclature, dimensional analysis, presentation of data, chemical economics, etc. In the remarkably complete article on chemical literature, there is, however, little mention of the importance of literary style, though in this respect the articles in the encyclopædia are commendably well presented. The use of unnecessary technical terms is always a temptation, and an expression such as "the armamentarium of gas analysis" is not very elegant. I have found few misprints and few mistakes. In so large a field to be covered there are sure to be faults to find; thus one could grumble over a quotation from a paper to which reference is made in the article on hydrogen peroxide. But, among so much which is good and useful, to cavil is misplaced.

There is no doubt that this extensive and valuable encyclopædia will find place on the shelves of many laboratories in spite of its bulk and its considerable cost. It will be valuable to the general reader who wants to widen his knowledge, for the articles are readable and informative, and to the specialist it will also be valuable as a work of reference, particularly if it is kept up to date by the issue of supplementary volumes. The specialist will, of course, find much which is omitted and perhaps much to criticize, but the attempt to present in this encyclopædia the state of contemporary knowledge in all that pertains to chemical technology is certainly an ambitious one; in my opinion it is on the whole successful.

ALFRED C. EGERTON

HOUSE PAINTINGS IN ANGOLA

Subsídios Para a História, Arqueologia e Etnografia dos Povos da Lunda

(Museu do Dundo, Publicações Culturais No. 18.) Por José Redinha. Pp. 32+55 plates. (Lisboa: Companhia de Diamantes de Angola, 1953.)

RESEARCH work on the archæology and ethnology of the province of Lunda (Angola) in connexion with the Museum at Dundo is subsidized by the cultural department of the Belgian diamond company in Angola—Companhia de Diamantes de Angola. As a result, a number of splendid monographs have already appeared, dealing with various matters of interest in the area. The present volume is compiled by the curator of the Dundo Museum, Dr. José Redinha, and is concerned with paintings made by the natives on the clay walls of their houses, both inside and out, during the dry season of the year, June–September. The external paintings, at any rate, are completely destroyed during the rainy season. Except for a short explanation in Portuguese and a map, the volume is entirely devoted to coloured illustrations of the paintings. They are of very great interest to all students of art in the southern half of Africa. They do not recall the true bushman or pre-bushman art groups, but there is a feeling of similarity with some of the later art manifestations farther south. It is true that geometric design predominates in Lunda, but figures of animals and humans occur, and some of these are not unlike some of those found not so far away on rocks in south-west Africa.

There is no doubt that the Bantu have artistic ability. Canon Patèrson, of Cyrene College, sent me some time ago a number of paintings made by Bantu children at the College, which he claims are free from European influence. They recall many to be found illustrated in the volume under review. Of course, the modern Bantu see things their forerunners never dreamed of—there is a delightful stylized picture of

ASSISTANT DIRECTOR, to take charge of a team of chemists, physical chemists, physicists and mathematicians, engaged on a comprehensive scientific study of the physical and chemical properties of rayon and synthetic fibres, and problems associated with the application of these fibres—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

BRITISH RUBBER PRODUCERS' RESEARCH FELLOW (with a good honours degree in engineering or physics, and industrial or research experience) for research into the mechanical properties of rubber—The Registrar, The University, Nottingham.

ENGINEERS, PHYSICISTS, PHYSICAL CHEMISTS and METALLURGISTS (Senior Scientific Officer and Scientific Officer grade) (with an appropriate first- or second-class honours degree or equivalent high professional attainments) in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.246/52A/T2.

EXTENSION LECTURER (with high academic qualifications in pure science, preferably in physics or chemistry) IN SCIENCE, to lecture at an advanced level to science graduates in industry, etc., principally in Cumberland—The Director of Extra-Mural Studies, King's College, Joseph Cowen House, 153 Barras Bridge, Newcastle-upon-Tyne 1.

LECTURER (with a good honours degree in applied or pure science, and research and industrial experience) IN MECHANICAL ENGINEERING—The Registrar, The University, Nottingham.

MATHEMATICS MASTER (with high honours degree)—The Head Master, Lancing College, Shoreham-by-Sea, Sussex.

METALLURGIST (with a degree in metallurgy or equivalent qualification, and preferably with previous industrial experience) for work entailing the application of research results in industrial practice—The Secretary, British Non-ferrous Metals Research Association, 80–91 Euston Street, London, N.W.1.

MINING GEOLOGIST (with B.Sc. degree with honours in mining geology) in the Colonial Geological Survey Service, Sierra Leone, for duties which include search for new mineral deposits, mapping, petrology and mineralogy of known mineral deposits, geological mapping, geophysical prospecting by resistivity and magnetometry—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.105/15/02.

PHYSICIST (with first- or second-class honours degree in an appropriate scientific subject, of a United Kingdom or Commonwealth University, or an equivalent qualification) IN THE COLONIAL INSECTICIDES RESEARCH UNIT, at the Ministry of Supply Chemical Defence Experimental Establishment, Porton, near Salisbury, to undertake research work in connexion with the application of chemical formulations for the control of pests of public health and agricultural importance—The Under-Secretary of State, Research Department (S.610), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

PHYSICISTS (with good honours degree, and some experience or training in research, not necessarily in textile research), for work on textile problems—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, near Manchester.

SCIENTIFIC OFFICERS (with first- or second-class honours degree in a suitable subject, or equivalent qualifications) in the Department of Scientific and Industrial Research, Mechanical Engineering Research Laboratory, East Kilbride; MATHEMATICIAN or MECHANICAL ENGINEER, for work on stress distribution and fatigue problems (Ref. C.16/54A); ELECTRICAL ENGINEER or PHYSICIST, for work on application of noise control techniques to the suppression of noise in machinery (Ref. D.20/54A); PHYSICIST or PHYSICAL CHEMIST (with sound knowledge of classical thermodynamics) for preparation of thermodynamics tables (Ref. A.11/54A); ENGINEER or PHYSICIST, for investigation into the fundamental mechanism of plastic deformation of materials (Ref. A.12/54A)—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

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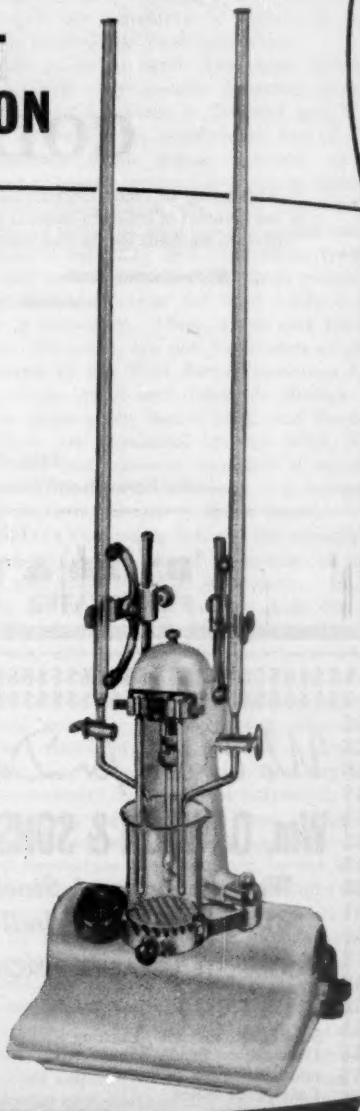

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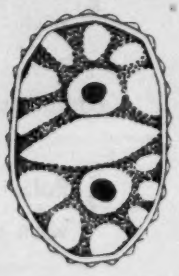

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PROTECTION OF BIRDS IN BRITAIN

IN Great Britain there are two main sets of laws dealing with the protection of birds—the Game Acts and the Wild Birds Protection Acts.

In contrast to some other European countries, where game birds may include thrushes, skylarks and even grebes, game birds in England and Wales are strictly defined in the main Game Act of 1831, which designates black game, bustard, grouse, partridge and pheasant under this heading, and lays down the close times which are to be observed for these species. In addition, game birds are also subject to strict controls regarding sale, possession, trespass and so on, and can only be shot by those possessing a game certificate, whereas for wild birds a gun licence only is necessary. Duck, geese and waders, although shot for sport, are not designated as game and are covered by the Wild Birds Protection Acts. Woodcock, snipe, quail and landrail, though not designated as game in the Act of 1831, and the close times of which are regulated by the Wild Birds Protection Acts, are, however, included in some of the provisions of the Game Acts, and it is necessary to possess a game certificate to shoot them.

The Wild Birds Protection Act of 1880 superseded all previous Acts for the general protection of birds and formed the main basis of legislation. In the ensuing fifty years, thirteen further Acts for the protection of birds were made law; further, in the course of time, 250 local orders have been added making various alterations regarding close times, etc. The Acts of Parliament have to be read together with the local order to ascertain what amount of protection any particular bird may have—and, in short, the law is so complicated and unwieldy that few people understand it, much less enforce it.

The need for new legislation has been recognized for nearly half a century. So long ago as 1914, a departmental committee was appointed by the Home Secretary under the chairmanship of the Right Hon. E. S. Montagu, M.P., to make recommendations for clearing up the confusion of the bird protection laws. This committee made its report in 1919; but since that date, six further Acts have been passed. Various societies and individuals have sought to introduce new measures to end the existing state of confusion, and committee after committee of ornithologists and other experts have spent much time and trouble in drawing up reports to this end. But the years have passed without any result from their labours.

After the War the Home Office Wild Birds Advisory Committee was reconstituted under the chairmanship of the Earl of Ilchester and continued the work of preparing a single Bill for the Protection of Birds, which would incorporate and simplify all necessary provisions contained in existing legislation with the addition of further provisions to meet modern requirements. Concurrently, a Scottish Wild Birds Advisory Committee worked on the same lines, and the agreed proposals of the two Committees form the main provisions of two Bills placed before Parlia-

ment, one in the House of Lords, sponsored by Viscount Templewood, which received its second reading on November 11, 1953, and a private member's Bill in the Commons, sponsored by Lady Tweedsmuir, which received its second reading on December 4, 1953.

Under both these Bills, no less than fifteen complete Acts of Parliament and also parts of several more are repealed, which gives some idea of the much greater simplification and clarity which should result.

The two Bills, being based on the proposals made by the Advisory Committees, are very similar and only vary in certain details. The fundamental provision is the change to the modern conception of affording protection throughout the whole year to all birds, excepting those causing damage, which may be killed at any time, and also those which are termed 'sporting birds' and may be killed during certain periods of the year only. The principle of departing from the old system of making long lists of birds which are to receive protection has already been adopted by other countries, notably by Northern Ireland in 1931, and forms the basis of the International Convention for the Protection of Birds which was signed *ad referendum* by the representatives of twelve European countries in Paris in 1950 (*Nature*, **167**, 173; 1951). Under the old system, if a rare bird appeared in Great Britain it was not legally protected unless it happened to be mentioned in a list, either statutory or local; but under the new provision all rarities will be automatically provided for under the omnibus protection accorded to all birds.

Four schedules are added to the Bills. The first contains the very rare species, the killing or taking of which at any time is subjected to increased penalties. A second part of this same schedule contains a list of species considered as sporting birds but which, though not uncommon, rarely breed in Great Britain. They are, therefore, during the breeding season, given the additional safeguard of increased penalties, though they may legitimately be killed at other times. The special penalties also apply to the taking of eggs of all birds in this schedule. The second schedule contains a list of birds which are considered harmful in one way or another and which may be killed at any time. In order to avoid the wholesale destruction of such birds, the power to destroy them is limited to owners and occupiers of land, and certain statutory bodies, or persons authorized by them. The third schedule contains a list of the sporting birds which may be shot outside a specified close season, and the fourth schedule consists of birds which may not be sold alive, unless they are close-ringed specimens bred in captivity. This last schedule is a re-enactment of the Bird Protection Act 1933, which was designed to stop the traffic in British wild birds.

In the past, legislation with regard to bird protection has proved far too inelastic, and with rapidly changing conditions this state of affairs is unworkable. A common species may become scarce; or a species which is quite innocuous in small numbers may become the reverse if there is a large increase. In the present Bills, allowance is made for such changes by investing the Secretary of State with the power to make any necessary adjustments to the schedules. Exceptions to the provisions of the Bills may also be made, by means of licences, for science, education and so on; and agriculture, fisheries and other interests are safeguarded. Statutory committees on wild birds to advise the Secretaries of State for England and Scotland are to be appointed.

In the past, certain methods of taking and killing birds have been prohibited, mainly on account of the cruelty involved, and these prohibitions have been incorporated in the Bills. To these have been added certain other methods which are prohibited, not so much on account of any cruelty involved, but to avoid undue slaughter of birds in large numbers and to make the odds brought about by modern methods of destruction less heavy against the quarry.

The need for an international point of view in bird protection is now generally recognized, and this is provided for in the new Bills by restrictions on the import of certain birds and eggs, and power is given to the Secretary of State to prohibit the import of any bird or egg for the whole or part of a year. In this way international co-operation with any country which is endeavouring to prevent the exploitation of any species can be achieved; a precedent for this was made in the Protection of Quails Act, 1937, which prohibited the import of live quails during certain months, a measure in support of the action taken by the Egyptian Government in prohibiting the export during the same period.

It is generally accepted that the commercialization of a species is its greatest danger, and to this end restrictions are placed on the sale of certain birds, alive or dead, and the sale of eggs of birds which have nested in the British Isles (those of certain gulls only excepted).

The question of the protection of wild birds' eggs is one of great difficulty. In the International Convention for the Protection of Birds, the general policy of according the same protection to eggs as to birds themselves is followed, subject to certain exceptions, and this method has been adopted with success in other countries, including Australia. The Wild Birds Advisory Committee, on the whole, also took this view; but a very decided opposite opinion has been voiced by many people, including the Government spokesmen, the contention being that it is highly undesirable to create a criminal offence in a young boy taking a common bird's egg. That this state of affairs already exists in a large number of counties, in some of which practically every British nesting bird's egg is protected by county order, does not alter this view. This difficult question has been dealt with in different ways in the two Houses; in the House of Lords' Bill, only eggs of the rare birds (Schedule 1) are protected by statute, but power is given to the Secretary of State to prohibit by Order, affecting the whole or part of Great Britain, the taking or destruction of the eggs of any wild bird specified. This maintains the present situation so far as eggs are concerned, and retains the long local lists which it is so desirable to eliminate.

In the Commons, the other approach has been taken of according protection to the eggs of all wild birds except for those of the harmful birds (Schedule 2) or "of any other common wild birds which the Secretary of State may by Order made with respect to the whole or any specified part of Great Britain prescribe for the purposes of this paragraph". This again is not a simple solution, for a list of birds' eggs which may be taken is, in the opinion of some people, a direct incentive to plunder birds' nests; moreover, to draw up such a list would be a far from easy task.

In the Bills, power to establish bird sanctuaries is given to provide for such areas which are not covered by the National Parks Act of 1949, enforcement of the law is made simpler and penalties for infringement are increased in accordance with present-day standards.

The Game Laws are in no way affected by the Bills except in so far as they mention the landrail and quail. These two species, having become very scarce, are included in the first schedule of the new Bills; the relevant passages regarding the shooting of these birds in the Game Acts 1831, 1832 and 1860 are therefore repealed.

Legislation in Great Britain for the protection of birds, as has been said, has become involved and cumbersome, and a revision was overdue. The present Bills, while not wholly satisfactory, seem to provide, in their different ways, for the protection of birds, and are in line with international feeling on the subject; it is to be hoped that there will be no undue delay in one or other reaching the Statute Book.

THE CASE FOR NATURAL SELECTION

Evolution in Action

Based on the Patten Foundation Lectures delivered at Indiana University in 1951. By Dr. Julian Huxley. Pp. 160. (London: Chatto and Windus, 1953.) 9*s*. 6*d*. net.

IN a very short time biologists, all over the world, will celebrate the centenary of "The Origin of Species by means of Natural Selection". There may be some heart-searching; there will certainly be a great deal of discussion.

Darwinian orthodoxy demands implicit faith in the efficacy of natural selection operating on chance mutations. Subscribe to this and all doubts and hesitations disappear; question it and be forever lost. The case for orthodoxy can seldom have been stated with greater cogency and enthusiasm than by Dr. Julian Huxley in "Evolution in Action". A few readers, perhaps rather pagan in their outlook, may think it a little strange that, if the case is quite so strong as they are asked to believe, it should still be necessary to argue the merits of natural selection with almost evangelistic vigour.

On one point all biologists are agreed: the basic concept of organic evolution has, for a century, stood unrivalled as a contribution to biological thought. As a working hypothesis it opened up and exploited vast new fields of palæontological, anatomical and embryological inquiry. The status of natural selection is not quite so high. True, it is the only theory we have; but when judged as a working hypothesis it is disappointing to find so little advance in a hundred years. What new facts have been brought to light? How far can it be shown to have elaborated the pageantry of animal life since 1859? A century is a fantastically short period of cosmic time, and all sorts of queer, exciting and improbable things may happen in five hundred million years; so, if we accept 'possibility' as a basis for scientific thought, why worry? Dr. Huxley admits quite frankly: "No one would bet on anything so improbable happening; and yet it *has* happened. It has happened thanks to the workings of Natural Selection and the properties of living substance which make Natural Selection inevitable". What more can be said, except possibly to suggest that there may be a slight difference between something that 'has happened' and one which 'may have happened'. No amount of argument, or clever epigram, can disguise the inherent improbability of orthodox theory; but most biologists feel it is better to think in terms of improbable events than not to think at all; there will always be a few who feel in their bones a sneaking sympathy with Samuel Butler's scepticism: " . . . there must have been a little cheating somewhere with these accidental variations [mutations] before the eagle could have become so great a winner". How far the heathen will be converted by Dr. Huxley is difficult to say.

The theory of natural selection implies the survival of organisms possessing functional advantages over their predecessors or rivals. Strange as it may seem, one immediate effect of the "Origin" was a marked recession in the study of animal function. There was, and still is, a tendency for morphologists to ascribe to organs and structures functional significance for which there was, or is, little observational evidence. In this respect "Evolution in Action" is by no means guiltless; it goes a considerable way beyond the physiological facts. Is Dr. Huxley quite sure that the loss of the lateral digits by the ancestors of the horse gave them an "additional turn of speed"? And, is he certain that the parallel between increasing complexity of anatomical structure (so clearly displayed throughout vertebrate evolution) and increasing complexity or versatility of behaviour is quite so obvious as he suggests? In what ways is the behaviour of a frog, a lizard, or even a sheep, an 'advance' on that of a stickleback? What about the hoary old story of snakes walking by their ribs?

To lay readers the more exciting part of "Evolution in Action" deals with the position of man in relationship to the rest of the animal world. To Dr. Huxley, man is an organism in a class apart from all others. In many ways man is more distinguished; but most readers will be sorry to read that "the human species to-day is burdened with many more deleterious mutant genes than can possibly exist in any species of wild creature". It seems a great pity that natural selection should have met its Waterloo just when it was most needed.

In the jungles of the past Nature guards her secrets with particular care, and it is a brave man who ventures far from the recognized tracks; it is so much easier to sit and criticize more adventurous spirits. Dr. Huxley's aim is not to comfort the despondent but to hit the dragons of Improbability stoutly on the nose and to give the world "a real feeling of the unity and sweep of evolution . . . as a self-transforming process . . . building its future by transcending its past". He has succeeded.

J. GRAY

CARBOHYDRATE CHEMISTRY

Advances in Carbohydrate Chemistry

Edited by Claude S. Hudson, Melville L. Wolfrom, Sidney M. Cantor. Vol. 7. Pp. ix+370. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1952.) 7.50 dollars.

SINCE the first volume of "Advances in Carbohydrate Chemistry" was published in 1945, this series has established itself as indispensable both to those who work in this field, and to those workers in other fields who wish to be well informed about sugar chemistry. The present volume maintains the high standard set by earlier volumes of the series. It contains eight articles, five from Britain, two from the United States and one from Germany.

The first of the articles, "The Methyl Ethers of the Aldopentoses and of Rhamnose and Fucose", contributed by R. A. Laidlaw and (the late) E. G. V. Percival, continues the series on the methyl ethers of the sugars started in earlier volumes. Methylation remains the backbone of structural studies in carbohydrate chemistry; this authoritative article will be of particular interest to those engaged in structural studies of the naturally occurring pentosans and of plant gums and mucilages.

The second article, "1,6-Anhydrohexofuranoses, a New Class of Hexosans", by R. J. Dimler, concerns two compounds, D-glucosan $<1,4>\beta<1,6>$ and D-galactosan $<1,4>\alpha<1,6>$, which are of considerable interest in that they contain a 1,2-glycol system which is not attacked by sodium metaperiodate. This observation is important in view of the widespread use of and increasing dependence on this reagent to detect 1,2-glycol systems; but I am inclined to the opinion that the article would have been more valuable had it been delayed until work designed to test some of the theories advanced to explain this resistance to oxidation had been completed.

The next two articles concern the ketoses. C. P. Barry and J. Honeyman review "Fructose and its Derivatives", and J. V. Karabinos reviews "Psicose, Sorbose and Tagatose". Both articles give excellent accounts of their subjects, although the addition of a discussion of the fructose phosphates, especially of fructose 1,6-diphosphate, would have been welcome in view of their biochemical importance. No mention is made of the tagatose 6-phosphate described towards the end of 1949 by Totton and Lardy[1]. Since Dr. Karabinos's review contains only two references (probably added in proof) to papers appearing at a date later than 1949, it is probable that this publication of Totton and Lardy appeared after the review was completed. If this is so, then the delay between the completion of the article and its publication is considerable and strengthens my opinion that all articles of this type should bear the date of receipt of the manuscript by the editors.

The fifth article, "Acetals and Ketals of the Tetritols, Pentitols and Hexitols", by S. A. Barker and E. J. Bourne, is a valuable account of the preparation and properties of these compounds and includes an interesting discussion of the most probable manner in which a given carbonyl compound would condense with a given polyhydric alcohol. The sixth article, "The Glycals", by B. Helferich, has been translated by W. Pigman from the original German. The unsaturated sugar derivatives are not as widely known as they might be, and it is to be hoped that this article on glycals will be followed fairly soon by one on the glycoseens. "The Chemistry of the 2-Amino Sugars (2-Amino-2-Deoxy-Sugars)" is discussed by A. B. Foster and M. Stacey. Members of this group of compounds are of considerable interest, both intrinsically and as structural components of the mucopolysaccharides.

All these seven articles in the volume give long and apparently exhaustive tables of selected physical constants of derivatives of the compounds under review.

The final article, "The Size and Shape of some Polysaccharide Molecules", by C. T. Greenwood, reviews the application of physical methods to the determination of the molecular weights of polysaccharides other than starch and cellulose and shows the importance of the use of all possible methods of study before hazarding any suggestion as to the structure of any polysaccharide. In this article I found that the editorial policy of the use of expressions of the type $(0{\cdot}7)10^6$ and $0{\cdot}7(10)^6$ in place of the more familiar $0{\cdot}7 \times 10^6$ was at first confusing and later irritating.

The articles as a whole are well written. The printing is clear and the paper and binding excellent. A few trivial misprints were noted, among which were four cases of the value for the diffusion constant (D) in the last article being given in terms of 10^7 instead of 10^{-7}. The volume contains comprehensive author and subject indexes; the entries in the latter were compiled using the recently adopted rules of carbohydrate nomenclature[2], but the articles to which they refer were written before these rules came into force. There is, however, no confusion.

To sum up, the volume is a valuable contribution to the literature and should be in the possession of all who are interested in carbohydrate chemistry.

L. J. HAYNES

[1] Totton, E. L., and Lardy, H. A., *J. Biol. Chem.*, 181, 701 (1949).
[2] *J. Chem. Soc.*, 5108 (1952).

CHEMICAL TECHNOLOGY

Encyclopedia of Chemical Technology

Edited by Raymond E. Kirk and Donald F. Othmer. Vol. 4. Cineole to Dextrose; pp. xvi+969. (1949.) Vol. 5, Di- to Explosions; pp. xvi+992. (1950.) Vol. 6, Explosives to Furfural; pp. xvi+1008. (1951.) Vol. 7, Furnaces to Iolite; pp. xvi+982. (1951.) Vol. 8, Ion Exchange to Metal Plating; pp. xvi+944. (1952.) Vol. 9, Metal Surface Treatment to Penicillin; pp. xvi+944. (1952.) Vol. 10, Pentacene to Polymethine Dyes; pp. xvi+976. (1953.) (New York and London: Interscience Publishers, Inc.) 25 dollars or £8 15*s*. each volume.

A HUNDRED years ago, the chief source of information bearing on chemical technology was Dr. Ure's "Dictionary of Arts, Manufactures and Mines". At the turn of the century Watt's "Dictionary of Chemistry" was available, but for general reference there was not much else. Thorpe's "Dictionary of Applied Chemistry" and Ullmann's "Enzyklopädie der Technischen Chemie" came into use later. The first volume of Thorpe's "Dictionary" had, however, appeared in 1890.

Turning over the pages of Kirk and Othmer's "Encyclopedia of Chemical Technology", of which Vols. 1–10 have now appeared, the tremendous progress of chemical technology during the past fifty

years is strikingly demonstrated. Already there are ten thousand pages up to the letter P, and more is yet to come. The subjects included in this encyclopædia confirm the statement which is often made that chemistry nourishes the growth of all technology. One only needs to cite at random a few of the headings to separate articles to illustrate this statement—lubrication, furnaces, malaria chemotherapy, metallic coatings, lamp manufacture, eggs. There are, of course, many articles relating to the different branches of chemical industry—fuels, glass, fermentation, explosives and so on. Articles also are to be found on the techniques—instrumentation, electronics, gas analysis, mass spectroscopy and many other such subjects. The various processes proper to chemical engineering—drying, distillation, crystallization, mixing—are treated in an up-to-date way with suitable photographs and diagrams of plant. There will be found articles on different physical and physical-chemical subjects, such as heat transfer, diffusion, dialysis, electrochemistry, etc., which underlie chemical processes and chemical engineering methods. Besides all this, information is provided about individual chemical substances (organic and inorganic), their properties, their use, their methods of preparation or manufacture and the economic aspects relating to their supply. Pharmaceutical products, biochemical preparations, dyes and intermediates (more than a hundred pages), etc., are included. The article dealing with cosmetics, because of the wide variety of products, is even larger than that on iron; the section of the latter dealing with the blast furnace is perhaps rather too compressed, considering the scale of production with which the blast furnace is concerned. By the careful cross-referencing and the grouping of classes of compounds together, for example, hydrocarbons, petroleum products, cyanides, etc., it has been possible for the editors to provide much information without too much repetition and elaboration.

The articles are written by specialists, and the editors have taken trouble to maintain as uniform a treatment as possible and a high standard. Each article is followed by a brief bibliography. The presentation and printing are pleasing. Most of the contributors are working in the United States; many are widely known for their work throughout the world. The information collected in these volumes is a record of the state of chemical technology in the New World rather than the Old, and this is exemplified on turning up the sections on gas—natural gas, manufactured gas and carbonization: manufactured gas has greater relative importance in Britain than in America, and the technology is somewhat different.

The proportion of the world's trade in chemicals at the present time is nearly as great in the United States as in the whole of the rest of the world, and the turnover has increased at a much greater rate in recent years than in Britain; the rate of increase is greater also in Switzerland. The installation of refineries in Britain and development of other processes may help to widen the basis of chemical industry in this country. Nevertheless, it is comforting that penicillin, polythene and paludrin, to mention three new products under the letter 'P' alone, have their origin in British laboratories.

There are useful articles on such subjects as literature, nomenclature, dimensional analysis, presentation of data, chemical economics, etc. In the remarkably complete article on chemical literature, there is, however, little mention of the importance of literary style, though in this respect the articles in the encyclopædia are commendably well presented. The use of unnecessary technical terms is always a temptation, and an expression such as "the armamentarium of gas analysis" is not very elegant. I have found few misprints and few mistakes. In so large a field to be covered there are sure to be faults to find; thus one could grumble over a quotation from a paper to which reference is made in the article on hydrogen peroxide. But, among so much which is good and useful, to cavil is misplaced.

There is no doubt that this extensive and valuable encyclopædia will find place on the shelves of many laboratories in spite of its bulk and its considerable cost. It will be valuable to the general reader who wants to widen his knowledge, for the articles are readable and informative, and to the specialist it will also be valuable as a work of reference, particularly if it is kept up to date by the issue of supplementary volumes. The specialist will, of course, find much which is omitted and perhaps much to criticize, but the attempt to present in this encyclopædia the state of contemporary knowledge in all that pertains to chemical technology is certainly an ambitious one; in my opinion it is on the whole successful.

ALFRED C. EGERTON

HOUSE PAINTINGS IN ANGOLA

Subsídios Para a História, Arqueologia e Etnografia dos Povos da Lunda

(Museu do Dundo, Publicações Culturais No. 18.) Por José Redinha. Pp. 32+55 plates. (Lisboa: Companhia de Diamantes de Angola, 1953.)

RESEARCH work on the archæology and ethnology of the province of Lunda (Angola) in connexion with the Museum at Dundo is subsidized by the cultural department of the Belgian diamond company in Angola—Companhia de Diamantes de Angola. As a result, a number of splendid monographs have already appeared, dealing with various matters of interest in the area. The present volume is compiled by the curator of the Dundo Museum, Dr. José Redinha, and is concerned with paintings made by the natives on the clay walls of their houses, both inside and out, during the dry season of the year, June–September. The external paintings, at any rate, are completely destroyed during the rainy season. Except for a short explanation in Portuguese and a map, the volume is entirely devoted to coloured illustrations of the paintings. They are of very great interest to all students of art in the southern half of Africa. They do not recall the true bushman or pre-bushman art groups, but there is a feeling of similarity with some of the later art manifestations farther south. It is true that geometric design predominates in Lunda, but figures of animals and humans occur, and some of these are not unlike some of those found not so far away on rocks in south-west Africa.

There is no doubt that the Bantu have artistic ability. Canon Paterson, of Cyrene College, sent me some time ago a number of paintings made by Bantu children at the College, which he claims are free from European influence. They recall many to be found illustrated in the volume under review. Of course, the modern Bantu see things their forerunners never dreamed of—there is a delightful stylized picture of

a motor-car from a site near the River Chiumbe. But it does appear from Canon Paterson's evidence and now from the Lunda examples that the modern folk make elaborate paintings either on drawing paper or on the clay walls of their houses without having been taught by Europeans. The human beings sometimes appear in a very stylized manner, recalling those found in rock-shelters in southern Spain and dating there to the Copper Age. But there is no need to try to suggest any connexion because such conventionalizations of the human form occur in many places and are of many different dates; they occur, too, on the walls of rock-shelters in the New World.

The Diamond Company of Angola is to be congratulated on the time, trouble and money it devotes to archæological and ethnological research. The present volume is a notable contribution to knowledge and, incidentally, is a delightful picture-book for one's study.

M. C. Burkitt

DISPERSAL PROCESSES IN FUNGI

Dispersal in Fungi

By C. T. Ingold. Pp. viii + 197 + 8 plates. (London: Oxford University Press, 1953.) 18s. net.

THE enormous fecundity of the fungi has long been known by those whose business it is to protect crops from attack by pathogenic fungi, or to prevent spoilage of stored materials by moulds and decay of timber by wood-rotting fungi. It is evident, too, to those who grow micro-organisms in pure culture on a laboratory or industrial scale. More recently its importance has been appreciated for another reason, for air-borne fungus spores have been identified as respiratory allergens, and in Great Britain the bulk of the microscopic dust particles suspended in outdoor air in summer seems to be either fungus spores or pollens. Bacteria also occur in outdoor air; but, as Pierre Miquel found seventy years ago, they are usually much less numerous than fungus spores—mainly because, unlike bacteria, the fungi have evolved a weird variety of mechanisms which propel their spores into the air. Other adaptations serve to aid their dispersal by animals, especially insects, and by water.

In this little book, which is addressed "to all those concerned with fungi as living organisms", Prof. Ingold lucidly describes the processes of fungus dispersal. It will be valued not only by the more academic biologists and by students with examinations to pass, but also will be a mine of information to those with a practical interest in the way fungi get into places where they are not wanted.

After a brief introductory survey, the remainder of the first half of the book is taken up with a full account of spore liberation. Some of this material has been used in the author's well-known book on "Spore Discharge in Land Plants", and about a fifth of the excellent text-figures are from the same source. The new book, however, is in no sense a second edition of the earlier one. Dispersal processes after liberation are surveyed in the light of the rapid developments of the past dozen years. The processes of liberation accomplish only part of the dispersal process, and when discharged from its parent fungus body, the spore is transported to a greater or, more commonly, shorter distance by external agencies. These are considered in the last half of the book in separate chapters on spores in the air, dispersal by insects, dispersal by large animals; and there is a short chapter on seed-borne fungi. Not only is the literature surveyed in a stimulating manner, but also Prof. Ingold contributes original observations on nearly all these topics, especially in the final chapter on water as an agent in the dispersal of spores. Much still remains to be done, and, as he reminds us, many of the dispersal processes are still obscure. There are a bibliography of about 140 references and eight beautiful plates.

P. H. Gregory

A SCIENTIST IN THE WORLD OF ART

Aesthetics and the Gestalt

A Collection of Essays and Other Writings. By Ian Rawlins. Pp. xi + 228 + 10 plates. (Edinburgh and London: Thomas Nelson and Sons, Ltd., 1953.) 18s. net.

THERE is nowadays a considerable number of scientists who are deeply interested in some or other of the arts, although the epoch of distinguished practitioners in both sides of the intellectual world is long past, perhaps since Leonardo da Vinci. Mr. Ian Rawlins is one of the far smaller minority who, officially trained in science, are able to indulge artistic interests to the extent of actual employment therein. He would not claim to be a creative artist, but he must allow us to recognize that he has a very weighty influence upon the arts; this influence he has exerted in two distinct ways, first as scientific adviser to the National Gallery and consultant on all questions of the safe keeping and material investigation of pictures, and secondly as a thinker and writer in the borderlines of general philosophy and æsthetics.

It is in this latter capacity that the reader meets him in this pleasant and often profound collection of essays. The principal adverse criticism might well be that the title is stupidly repellant: only a narrow range of British readers in science or art will be attracted by the word 'æsthetic', still fewer by 'gestalt'. Continental philosophical jargon causes English-speaking readers, even those concerned in the topics, to bristle like a dog, and it would be well to erase 'gestalt' from the dictionary as ruthlessly as most of us would erase 'existentialism'.

The little essays themselves belie that suggestion of self-conscious intellectualism. They are neat in thought and eminently readable, and even scientists who have thought the arts closed to them will find much to enjoy here. The pages range from a quantitative account of the atmospheric pollution of art galleries, through topics such as geometric theories of æsthetic appreciation, to historical problems from ancient Greece to modern Cambridge. Many are reviews which have appeared in *Nature*. After some cases, recently, of rather Victorian anti-religion in some scientific quarters, it is worth noticing how many of Mr. Rawlins's essays reveal a mind devoutly aware that there are aspects of experience needing other than scientific categories for their description. This is to be expected from someone who has escaped the narrowness of literary and material culture by opening a receptive mind to both.

Martin Johnson

Gem Testing

By B. W. Anderson. Fifth edition. Pp. 268. (London: Heywood and Co., Ltd., 1951.) 21*s*. net.

THE author, as director of the London Chamber of Commerce Precious Stone Laboratory, has unique experience in gem testing. That five editions of this book have been called for in ten years shows that it has filled a need both of the scientifically untrained jeweller, to whom it was originally addressed, and of the more advanced student.

Because of the value of the material, routine gem-testing must be non-destructive and is limited to physical methods. About half the text is devoted to their careful description and explanation. The basic physical properties, refractive index and specific gravity, serve to distinguish most of the natural gem species, although their determination is often made difficult by the mounting of the stone or limitations of the apparatus—for example, in the measurement of high refractive indices. A most useful additional property in such cases may be the absorption spectrum. Its use has been pioneered by the author to the extent that it now ranks as the key method in a number of cases. In this book is the only adequate description known to the reviewer.

With certain exceptions all these methods fail in that most important aspect of gem-testing, the distinction between natural stones and their synthetic, as opposed to imitation, counterparts, and the microscope becomes the *pièce de résistance*. Its use for this purpose is fully explained, and of the sixty-two text figures nearly half are photomicrographs; these are excellent in quality and selection.

The latter half of the text covers the identification of, and distinction between, all the principal gem-stones, including those of organic origin such as pearl and amber. In this, as in the first section, useful hints and examples abound. There are also an alphabetical summary of properties in tabular form, a glossary, tables of specific gravity and refractive index, and suggestions for further reading. Despite its superficial simplicity, this is an authoritative work, well produced in clear type.

G. F. C.

Geography from the Air

By F. Walker. Pp. vii+111+96 plates. (London: Methuen and Co., Ltd.; New York: E. P. Dutton and Co., Inc., 1953.) 30*s*. net.

THIS book provides a useful introduction to the correlation of geographical data with the air photographs from which maps are finally constructed. Such a technique is most favoured in undeveloped countries where information is otherwise not rapidly obtainable; but in Great Britain, the only source tapped by the author, many geographical and ecological features have been made or modified by man, and excellent maps prepared by more pedestrian methods exist. It would be desirable to include and discuss examples—which are certainly available from the British Dominions and Colonies—of untouched virgin country in diverse geographical, geological and climatic provinces; and to consider the uses of oblique photography, monochromatic filters, the habits of vegetation growing under natural control, and weathering action differing from that of the British Isles.

As regards details: it is not necessarily true (p. 11) that geological facts evident on air photographs are equally well observed on the ground, nor (p. 1) that there is no vertical scale distortion in a stereo-pair—it can be troublesome over mountainous country. Reference to the page-numbers of the text-descriptions ought to be made on the plates, only three of the ninety-six embodying pairs for viewing with a pocket stereoscope. Since the main force of the technique lies in the three-dimensional appreciation, the inclusion of more of such pairs would be preferred, though the effect of the process screen is disturbing. Plate 37 (p. 1 of text) should be Plate 38.

In recognizing that examples from overseas are lacking and that archæology and photogeology have received but scant attention, the author has disarmed criticism, for the subject is expertly handled within the limits chosen; but it is worthy of a wider range of treatment. This would be welcome in a later edition, which might well include a selected bibliography.

D. W. BISHOPP

Ants

By Derek Wragge Morley. (New Naturalist Series.) Pp. xii+179+15 plates. (London: William Collins, Sons and Co., Ltd., 1953.) 18*s*. net.

THE pleasantly discursive story of the author's own observations on the habits of ants, in Chapter 1, might have formed the happy beginning of a book for the non-technical reader with an interest in natural objects; the notes on the various species and the illustrated key, though not free from defects, could serve the same purpose. But as a scientific monograph that is said to give "a clear and excellent summary of the knowledge of these fascinating creatures", this book is scarcely a success. There is little of moment that cannot be found in Donisthorpe, Wheeler and nineteenth-century authors; the book lacks coherence and precision; and some of the truly fascinating aspects of ant biology, such as the structure and development of the colony and the determination of the castes, are virtually omitted (except for some details of mixed colonies). The chapters on anatomy are heavily weighted with details that are of interest principally in systematic work: in many cases the terminology is old-fashioned (for example, "chitin" for 'cuticle', p. 33; "bourreleted glands", p. 124), and there are a number of odd mistakes (for example, "mesonotal sternite", Fig. 5). The growth of ants is dismissed with extreme brevity; the distribution maps, given for every species, are often incomplete (for example, *Monomorium pharaonis*, which now has a respectable Scottish literature, is shown nowhere north of Essex). Some of the photographs, however, are excellent; it is a pity that the text is scarcely of the same standard.

J. A. DOWNES

Chemistry of Carbon Compounds

A Modern Comprehensive Treatise. Edited by Dr. E. H. Rodd. Vol. 1, Part B: Aliphatic Compounds. Pp. xvii+779–1462. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1952.) £5 15*s*.

THE second part of Vol. 1 of this work carries on the discussion of the aliphatic series begun in the first (reviewed in *Nature*, 170, 508; 1952) and deals with the more complex (and therefore more interesting) compounds of this type. After a description of the hydroxy-, amino-, aldehydo-, keto- and poly-carboxylic acids, there follows a series of chapters on the carbohydrates and their multitudinous derivatives. Authoritative coverage of this latter topic has been ensured by the expert knowledge of

Dr. J. K. N. Jones and the late Dr. E. G. V. Percival; the full and detailed treatment renders this section a very valuable source of modern information for the carbohydrate chemist. The volume ends with chapters on the proteins and the enzymes which supply the scaffolding of the modern ideas concerning these vital substances together with ample references for further detailed study.

The characteristic of the work developed in the first volume—that is, the ready availability of up-to-date leading references—is well maintained in the second part of this important compendium.

Physical Chemistry made Plain

An Aid for Intermediate Students and Others. By J. H. Mandleberg. Pp. viii+287. (London: Cleaver-Hume Press, Ltd., 1952.) 15*s*. net.

THE author, an industrial chemist, calls himself "a chronic and incurable non-mathematician". His purpose is to teach physical chemistry, at post-matriculation level, mainly through numerical examples, and he thereby hopes to promote its study "by removing some of its terrors". The material is divided into seventeen chapters. The author's method is to recount the general principles of the subject under treatment, to work out several illustrative numerical examples in considerable detail, making the procedures abundantly clear, and to add many more for the student to solve; answers are given to all the problems.

Great pains have been taken to meet the needs of less able students, and in this respect the work is exceedingly well done. Still, understanding comes to many a student only when he sees the graph drawn of the problem in question; yet, there is neither graph, labelled diagram nor line-illustration in the book. Moreover, I find but little support for the claim that "an attractive feature is the frequency with which the student is reminded of the relevance of his work to industrial processes". The author gives brief mention of some principles not susceptible of quantitative treatment at this level, but others he omits. The preface calls this book a "review of physical chemistry": it would be preferable to call it a book of chemical calculations. G. Fowles

Thermal Diffusion in Gases

By K. E. Grew and T. L. Ibbs. (Cambridge Monographs on Physics.) Pp. xi+143. (Cambridge: At the University Press, 1952.) 22*s*. 6*d*. net.

THERMAL diffusion in gases was predicted theoretically long before it was observed experimentally, and it is only during recent years that the consequences and importance of this effect have been fully developed. The immense stimulus given to the study of thermal diffusion and related phenomena by the utilization of this method for the separation of isotopes and gas mixtures resulted in a considerable output of experimental work. The publication of this monograph, which summarizes these developments, will be especially welcomed.

The emphasis in the monograph is largely on the experimental aspects, and Chapters 1–5 consist of an introduction to the theory of diffusion in gases, an account of the experimental methods and results, and the correlation of results with theory. In Chapter 7 the related phenomenon, the diffusion thermo effect—that is, the setting-up of a transient temperature gradient when one gas diffuses into another initially at the same temperature—is discussed from both the theoretical and experimental aspects. The remaining Chapters 7 and 8 describe the application of thermal diffusion to the separation of the components of gas mixtures and thermal diffusion in the liquid phase, respectively.

This is the only book of its kind containing both a comprehensive survey of the experimental field and a careful and clear exposition of the underlying theory. The book is well written and excellently produced, and it can be recommended to all interested in this subject.

Photoconductivity in the Elements

By Dr. Trevor Simpson Moss. Pp. x+263. (London: Butterworths Scientific Publications, Ltd., 1952.) 50*s*. net.

PHOTOCONDUCTIVITY is a subject which claims attention on two grounds: it provides a useful tool for examining certain aspects of the nature of the solid state and it has useful practical applications. Photoconductive materials have been studied intensively during the past few years, and this up-to-date book by Dr. T. S. Moss is therefore to be welcomed.

The book is divided into two parts. Part 1 is concerned with theoretical aspects of the properties of photoconductors. The treatment is clear, but the reader is assumed to have the background of, say, a physics graduate; those without this background will, however, be helped considerably by the numerous references given in the text. Part 2 gives a detailed review of experimental studies of the properties of certain photoconductive materials; photoconductive compounds are not included in this review, which is confined to the elements boron, carbon (diamond), silicon, germanium, grey tin, phosphorus, arsenic, antimony, sulphur, selenium, tellurium and iodine.

As a whole, the book is concise and well written; it provides a useful, if somewhat limited, survey of an important subject. A. H.

Dynamical Oceanography

By Prof. J. Proudman. Pp. xii+409. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1953.) 55*s*. net.

THIS book covers most of the principles of hydrodynamics that have application to oceanography. The author has a genius for concentrating on the central features of a problem. In a large part of the book the problem is not to solve the hydrodynamical equations, but to show how much can be derived from a few simple properties without actually solving them in detail. In the application to mean conditions, and therefore to steady states, a great deal can be done from continuity of mass and quantity of salt and the circulation theorem, particularly toward estimation of currents far from land. Turbulence and mixing are treated in some detail. Variation of conditions with time appears first in these chapters, in which estimates of eddy-viscosity appear. The rest of the book deals with tides, seiches and waves. The treatment has been deliberately confined to the simpler problems, and little is said about the formidable ones on tides in the open ocean that have been solved by the author and his colleagues.

Quantitative applications appear at many points, with checks against observation whenever these are available. The agreement is in some cases astonishing—for example, the calculation of co-tidal lines for some narrow regions with complicated boundaries, such as the English Channel. Harold Jeffreys

THE MEDICAL RESEARCH COUNCIL LINEAR ACCELERATOR AND CYCLOTRON

By CONSTANCE A. P. WOOD and G. R. NEWBERY

A NEW building (see Fig. 1) has recently been completed for the Medical Research Council at Hammersmith Hospital, London. This building houses two large machines for the acceleration of atomic particles. Installed in the south end of the building is an 8-MeV. travelling-wave linear electron accelerator; this machine has been designed specifically for X-ray therapy and is already in daily use for the treatment of patients. At the north end of the building, a 45-in. cyclotron is under construction. The central portion of the building consists of research laboratories on the upper floors and clinical rooms for patients on the ground floor.

The linear accelerator is installed in a treatment room (see Fig. 2) which is surrounded by walls of concrete four to six feet in thickness. There is no door to the treatment room; but easy access is afforded by means of an indirect corridor with concrete walls on either side. The protection thus afforded is much greater than is necessary simply for the safety of personnel; it is sufficient to enable work to be carried out in the adjacent research laboratories involving the measurement of minute quantities of radioactive material with Geiger counters and high-pressure ionization chambers. The radiation level at the control desk is less than one-hundredth of the recognized tolerance value. The operator at this control desk can see the patient under treatment by means of a periscope system of mirrors viewed through an air tunnel in the concrete wall.

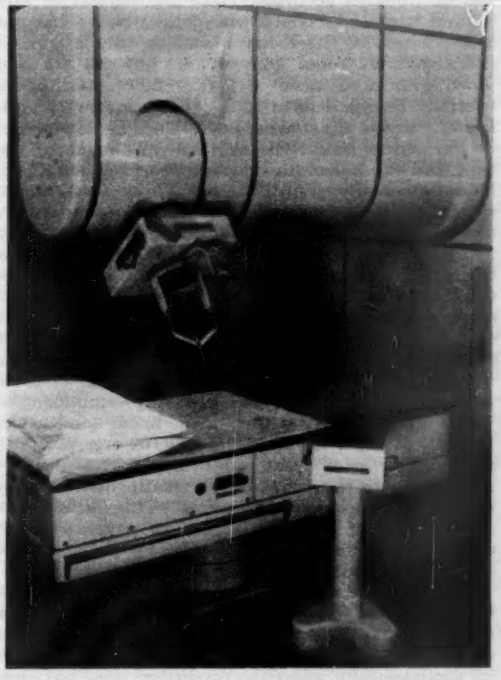

Fig. 2. Treatment room

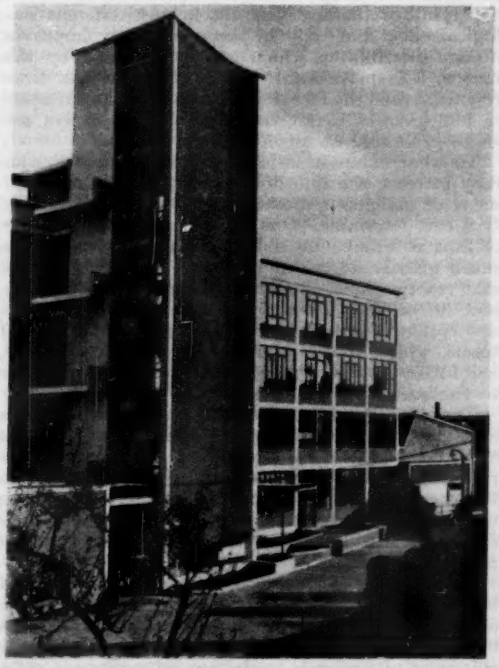

Fig. 1. Building for the Medical Research Council linear accelerator (right) and cyclotron (left)

The technical details of the 8-MeV. linear accelerator have already been described by Miller[1]. The accelerating tube is three metres in length; it is suspended from the ceiling, thus leaving the floor of the treatment room clear. The 8-MeV. electron beam passes out of the end of the accelerating tube into a rotatable X-ray head. In this, an electromagnet bends the electron beam through a right-angle before it strikes the gold transmission target to produce the beam of X-rays. The X-ray beam is then collimated to a maximum diameter of 26 cm. at 1 metre from the target by passing it through a conical hole in a series of tungsten–copper alloy blocks. The final dimensions of the X-ray beam can be controlled by means of an adjustable diaphragm system consisting of four 3-in. thick tungsten–copper alloy blocks moving in two interlocked pairs in a single plane. Thus any size of treatment field can be obtained, from 4 cm. to 20 cm. square, or any intermediate rectangle. Scales are provided for setting the size of the field, and circular fields can also be obtained by suitable inserts of tungsten alloy. The target-to-skin distance usually employed in treatment is 1 metre.

A lamp and mirror are provided to illuminate the treatment area on the patient's skin. In addition, front and back pointers on the X-ray head indicate the points of entry and exit of the central axis of the X-ray beam on the patient's skin. The dose-rate and the total dose administered in any one treatment are measured by ionization chambers built into the head of the machine and connected to d.c. amplifiers.

By rotation of the X-ray head, the X-ray beam can be directed accurately into the patient at any desired angle. To enable the patient to be brought into position in the X-ray beam, the whole floor of the treatment room can travel vertically up and down over a distance of 5 ft., and in addition a specially designed treatment couch can travel horizontally across the moving floor. The angular motion of the X-ray beam, the vertical movement of the floor and the horizontal movement of the couch can be automatically co-ordinated by an electronic servo system enabling the patient to be moved in an arc around the machine. As a result, once the entry point of the beam (marked by the front pointer) has been set correctly on the patient's skin, it is possible to adjust the angle of the beam until the exit point (as shown by the back pointer) is also correct, without ever altering the entry point. By this arrangement patients can be set up for treatment on this machine with greater accuracy and speed than is possible with the conventional type of X-ray equipment.

The high intensity output of the linear accelerator, 100–200 rads per minute (1 rad = 100 ergs per gm.) at a metre, is of great value in the treatment of patients, since the time of each treatment is thereby reduced to about two minutes. The initial large expense of the machine is thus to a great extent offset by the much larger number of patients who can receive treatment in a given time.

The control desk of the machine is simple and can be operated in the usual way by radiographers. The required dose can be set in steps of 10 rads up to a maximum of 600 rads; the machine switches itself off automatically when the prescribed dose has been administered.

There are, for the first time, incorporated in this one machine all the facilities needed to permit the full exploitation of the technical advantages to be gained by using very-high-energy X-rays in the treatment of malignant disease. It makes possible the delivery of an adequate dose to a deep-seated tumour of highly penetrating 8-MeV. X-rays collimated into a well-defined, high-intensity beam, which can be conveniently and accurately directed into the patient at any angle.

In Fig. 3 a comparison is made of the penetration of X-rays produced at 8 MeV., at 2 MeV. (approximately equivalent to radiation from a 1,000-curie cobalt source) and the conventional 200-kV. X-rays; the greatly increased penetration obtained at 8 MeV. is clearly shown. This figure also illustrates the build-up of intensity below the skin at 2 and at 8 MeV. This build-up, which occurs with supervoltage radiation, is due to the fact that the secondary electrons, which produce most of the ionization, are projected mainly in the direction of the incident beam and have a range which increases with the voltage. In the case of the 2-MeV. X-ray machine and the cobalt unit, the maximum dose is at 0·5 cm. depth, whereas this occurs at a depth of 2·0 cm. with 8-MeV. X-rays. This build-up of intensity below the skin and the high penetration of the X-rays produced by the 8-MeV. linear accelerator make

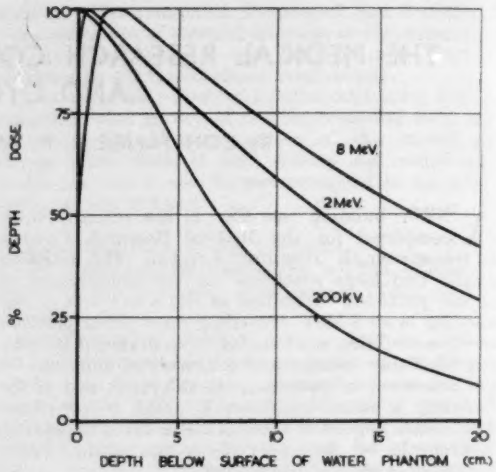

Fig. 3. Comparison of central axis depth doses for a 10 cm. × 10 cm. X-ray field, 200 kV., 2 MeV., and 8 MeV. in a water phantom

possible the delivery of an adequate dose to a deep-seated tumour without any damage to the overlying skin.

At one time it was thought possible that supervoltage X-rays might have a different biological effect from 200-kV. X-rays. A clinical experiment was therefore carried out at the Radiotherapeutic Research Unit of the Medical Research Council to compare the biological effect of 200-kV. X-rays and a radium beam which is equivalent to 2-MeV. X-rays[2]. As a result of this experiment, it was concluded that the great advantage to be expected from the use of supervoltage therapy was not in any different biological effect but only in the enormously improved dosage distribution which can be obtained by this means. Experimental biological work has since re-emphasized the fact that there is no great difference in biological efficiency between 200-kV. X-rays and those generated at much higher voltages.

To what extent this improved dosage distribution may increase the rate of cure in the radiation treatment of malignant disease only a prolonged clinical trial can determine. One advantage which is certain is that it will be possible to treat patients with a much greater degree of comfort. The reduction of skin reaction itself is of great value in X-ray therapy, and it can also be safely assumed that the lower absorption of energy in bone as compared with soft tissue, which occurs in supervoltage X-ray therapy, will lessen the risk of bone necrosis and so contribute to the success of treatment.

The 45-in. cyclotron, weighing some 180 tons, is still under construction; this machine is housed at the north end of the building in a large concrete room with ceiling and walls from six to ten feet in thickness. The room has two close-fitting sliding concrete doors weighing 35 and 190 tons. The cyclotron will be operated from a remote-control room.

The beam of fast neutrons which can be produced by the cyclotron will enable investigations to be carried out to determine the effect of neutrons on living and inert matter. There is no question of the efficiency of neutrons in destroying malignant cells. What is not known is whether this property can be

turned to advantage over other forms of radiotherapy in the treatment of malignant disease in patients.

Another use of the cyclotron lies in its ability to produce certain radioactive isotopes which cannot be produced in the atomic pile. The particular importance of this cyclotron lies in its ability to produce in a hospital certain isotopes which, on account of their very short life, must be used immediately they are produced. Facilities have been provided adjacent to the machine for this purpose.

[1] *Nature*, **171**, 297 (1953).
[2] Wood and Boag, M.R.C. Special Report Series No. 267, "Researches on the Radiotherapy of Oral Cancer" (London: H.M.S.O.).

DEXTRAN AND ITS APPLICATIONS

ON the evening of December 3 the Microbiology Group of the Society of Chemical Industry held a meeting in the hall of the Medical Society of London, 11 Chandos Street, London, W.1, presided over by Dr. L. A. Allen, at which various applications of dextran were discussed.

Prof. M. Stacey introduced the subject with a paper on "Polyglucose Structures with Special Reference to the Dextran Group". He commented on early work in Sweden and in Birmingham, saying that the dextran polysaccharides have achieved an important medical use as blood plasma substitutes or blood volume expanders, and their derivatives are possible anticoagulants. Since they can readily be produced from cane or beet sugar by fermentation methods on an industrial scale, other uses, such as colloids of precise size and shape, will doubtless be found for them.

Chemical and physical methods of carbohydrate chemistry are now so well developed and of such diversity that we can now determine with great accuracy the homogeneity, size, shape and molecular structure of most polysaccharides. Homogeneity can be determined by physical techniques such as measurements of optical rotation, electrophoresis, ultracentrifugal properties, diffusion, scattering of light, and immunochemical studies, all of which also give information on molecular size and shapes. Constituent units can be determined by hydrolysis with acids followed by paper and column chromatography, ionophoresis, etc., while acetolysis, methylation, periodic oxidation, infra-red studies, ionophoresis, etc., pick out the nature of ends of chains, repeating units, types of linkage and structures generally. Number average and weight average can all be determined by classical methods for dealing with macromolecules; for example, the physical methods already mentioned, viscosity measurements, and methods involving reaction at reducing-chain ends such as copper number measurements and the addition of labelled hydrogen cyanide.

Almost every type of polyglucose structure is now known where the glucose units are in the pyranose form. In starch the amylose component is a chain of at least two hundred glucose units joined by (1 → 4)-α-linkages, while the ramified amylopectin has short chains of twenty glucose units joined as in amylose but cross-linked by (1 → 6) linkages. Glycogen consists of shorter chains with (1 → 4)-α-linkages and (1 → 6) cross-linkages. Cellulose is entirely linear with very long chains of probably a thousand glucose units linked in the (1 → 4)-β manner. The polyglucose made by the crown gall micro-organism possesses mainly (1 → 2) linkages, while the yeast 'glucan' has mainly (1 → 3) linkages. Nigeran from *Aspergillus niger* has alternating (1 → 4) and (1 → 3)-α-linkages, and luteose from *Penicillium zukal* has a long glucosan chain with (1 → 6)-β-linkages.

The predominating linkage in the dextrans is the (1 → 6)-α-linkage, but a variety of types is known varying from completely linear structures to highly ramified types with additional (1 → 4)-α- and (1 → 3)-α-cross-linkages and combinations thereof. All are macromolecules with molecular weights of the order of millions. Great interest arises in methods for degrading the dextrans and in separating and selecting homogeneous fractions for infusion purposes. Breakdown can be effected by acidic, alkaline, enzymic and oxidative hydrolysis, or by ultrasonic or thermal treatment. Fractionation precipitation techniques, using mainly organic solvents and aqueous solutions, not only separate large and small molecules but will also pick out linear from branched chains—the infra-red technique being useful for rapid control of fractionation.

Recently, it has become possible to control the enzymic synthesis of polyglucose molecules and indeed to grow them to size. Great advances have been made in the enzymic synthesis of starch and glycogen. For these, phosphorylase acts upon glucose-1-phosphate to give the straight-chain amylose. This may then be acted upon by the branching '*Q*-enzyme', which effects chain-shortening by breaking about one in every twenty (1 → 4)-α-linkages and which then re-forms the molecule by creating (1 → 6) cross-linkages giving the highly laminated structures of glycogen and amylopectin. This 'transglycosylase action' is responsible for synthesizing the highly branched dextrans, for at least two enzymes seem to be involved: a (1 → 6)-α-linked straight-chain former and a transglycosylase which forms (1 → 4) and/or (1 → 3) linkages.

For polysaccharide synthesis generally three factors are needed: enzyme, specific substrate and receptor molecule. For dextran synthesis by *Leuconostoc* species, sucrose is a highly specific substrate, and preformed dextran forms the receptor molecule or 'primer'. When a small number of large dextran molecules is used to prime the reaction, macromolecules of very large size result. When a relatively large number of small dextran molecules is used to provide receptor groups for synthesis from non-reducing chain ends, they are all lengthened to the same extent, and relatively small dextran molecules result. Thus, it is now possible actually to grow dextran 'to size'—for example, to molecular weights of seventy thousand for infusion purposes. The method uses the living cell, whereas American workers are studying similar polymerizations with isolated enzyme systems.

Mr. A. E. James then presented a paper on "The Technology of Dextran Production", showing that the production of dextran for use as a plasma volume expander may be divided into five main stages: fermentation, degradation, fractionation, purification and final testing after bottling. Dextran is produced as a large macromolecule during the fermentation of sucrose by a selected strain of *Leuconostoc mesenteroides*, although the use of the dextran 'sucrase' enzyme has been reported in the United States. The dextrans produced by different organisms vary from almost linear to highly branched molecules. The

reduction of the molecular size of the native dextran to approximately that of the blood proteins may be achieved by several degradative steps such as acid or alkaline hydrolysis, thermal or pyrolytic breakdown, irradiation with ultrasonic vibrations or enzymic breakdown. Recent work has indicated the possibility of direct synthesis of the required molecular weight, thus avoiding degradation.

The material from degradation is very polydisperse, and the objectionable larger molecules and the useless small ones have to be removed by selective precipitation. Acetone and the lower alcohols have been used as precipitating agents. This process does not yield a homogeneous dextran with respect to molecular weight, and the commercially available transfusion solutions contain a range of molecular sizes dictated partly by medical requirements and partly by economic considerations. Ultrasonic degradation appears to be unique, as it yields a product requiring virtually no fractionation to yield a satisfactory medical preparation.

The desired fraction of dextran is freed from precipitants, pyrogen, ionic impurities and colour by selective adsorption and ion-exchange, and may then be filled directly as a solution in water, sodium chloride solution or glucose solution. Alternatively, it may be spray-dried for bulk testing and distribution. After bottling, rigorous chemical bacteriological and pharmacological tests are applied.

Dr. F. Fletcher followed with a discussion of the "Properties of Dextran from the Physiological Aspect". He pointed out that the maintenance of a normal blood volume depends on the hydrostatic pressure of the capillary blood and the colloidal osmotic pressure gradient between the plasma and tissue protein. Plasma contains albumin, globulin and fibrinogen; but it is the albumin fraction (55 per cent of total protein) of molecular weight about seventy thousand which mainly contributes to the colloidal osmotic pressure.

It is essential that any colloid intended as a replacement for plasma protein be retained in the blood vessels and not rapidly lost through the capillaries to the tissues or urine. The retained colloid must exert a colloidal osmotic pressure similar to that of the normal plasma protein. Dextran can be prepared to meet these criteria and is a satisfactory substitute for plasma protein.

Dextran fractions of various ranges of molecular weight have been studied, and the distribution and excretion-rates have been compared. The molecular-weight distribution of such fractions can be determined by ultracentrifuge, scattering of light, or techniques of the measurement of osmotic pressure, but it is more usual for measurements of intrinsic viscosity to be made. The relationship between intrinsic viscosity and molecular weight has been published by various workers.

The distribution of dextran in the body is influenced by its molecular-weight distribution. Relatively small molecules below a weight-average molecular weight of sixty thousand are excreted in the urine within a few hours after administration. Molecules slightly larger can also pass readily through the capillary walls into the tissue fluid, thus tending to reduce the effective osmotic pressure gradient. Therefore, on the basis of these physiological considerations, the higher molecular range of dextran used in Britain appears to be preferable for clinical use compared with dextran fractions of lower average molecular weight.

Prolonged storage of a non-physiological colloid in the body is undesirable. That dextran is metabolized in the body has been suggested by the finding of radioactive carbon dioxide in the expired air of animals receiving injections of dextran labelled with carbon-14, obtained by the *Leuconostoc* fermentation of radioactive sucrose. Structural differences exist between dextrans produced by different strains of *Leuconostoc mesenteroides*, and immunological studies on structurally different types of dextran might influence the type of material selected for clinical use.

Mr. A. W. Wilkinson continued the physiological discussion with a paper on "The Clinical Applications of Dextran". After paying a tribute to Prof. Stacey and other pioneer workers on dextran, he commented on its importance in blood studies, and went on to say that the cells of the living body are surrounded by an environment of extracellular fluid; at any moment this extracellular fluid may be arbitrarily divided into one quarter, which is within the blood vessels in the form of plasma, and three quarters, the interstitial fluid, which is outside the blood vessels in the immediate neighbourhood of the cells. This separation depends on a balance between the hydrostatic forces in the blood vessels and the interstitial space, and the osmotic pressure of the plasma proteins. In normal tissues flow in the capillaries is intermittent and depends chiefly on requirements related to tissue activity. After injury there is a very marked increase in capillary permeability in the injured tissues and the volume and protein content of interstitial fluid increases, this increase in volume being due to a greater turnover of fluid rather than to simple local accumulation, because lymph formation is also increased up to eight times. If the injury is large, so much fluid may be lost from the blood vessels that the volume of blood in active circulation may be reduced enough to cause reduction of the peripheral blood pressure and a state of 'shock'. Shock may also be caused by loss of whole blood. It is now recognized that, in shock, capillary permeability is increased only in the injured tissues.

The most satisfactory treatment of shock is by the early, rapid and complete replacement of lost blood or plasma by the transfusion of blood, plasma or a substitute for plasma, such as dextran. To be successful as such a replacement, the dextran must be fractionated so that as little as possible is lost in the urine or through the unusually permeable capillaries of the injured tissues and as much as possible remains within the vessels.

The effects of injecting a litre of a 6 per cent solution of dextran in 0·9 per cent saline have been studied in normal volunteers. There is an immediate reduction in packed cell volume and of total plasma protein and plasma albumin concentration. These changes afterwards slowly pass off, and the plasma dextran concentration, initially 1–1·5 gm./100 ml., falls slowly over 8–10 days to less than 0·1 gm./100 ml., but even at this time the packed cell volume remains below the original value. Detailed study of the changes during the first 24 hours after the infusion has shown that during the 2 hours or so following the initial increase in plasma volume, which varied from 0·3 to 1·3 litres, there is a reduction in plasma volume almost to the initial quantity. During this short period more than 40 per cent of the total quantity of plasma albumin in solution and nearly 40 per cent of the injected dextran leave the blood vessels. During the next 8–12 hours there is a gradual increase in plasma volume, and

the quantity of plasma albumin in circulation increases to that found immediately after the infusion stopped; but the increase in total circulating dextran is much less. After 24 hours only 8 per cent of the injected dextran has been recovered in the urine and 65–75 per cent remains in circulation within the vessels, so that about 20 per cent is untraced. The explanation of these changes seems to be that the acute overloading of the circulation produced by the rapid injection of this dextran solution is relieved by the loss of intravascular fluid into the interstitial space, with subsequent slow return over the next 8–12 hours. Similar results have been obtained in shocked patients, and two examples of the rapid and lasting improvement in blood pressure and clinical state were described.

All these volunteers exhibited 'reaction' which could be resolved into two phases, urticarial and vasomotor, that were separated in time. Whereas the urticarial phase may be due to the peculiar characteristics of the dextran used, the vasomotor phase seems to be related to the rapid shift of fluid from vessels to interstitial space.

Finally, Mr. A. R. Lockwood briefly reviewed "The Utilization of Dextran and some of its Derivatives". The current utilization of dextran in non-clinical applications depends largely upon the economic separation of the crude polysaccharide from the crude fermenter broths. Solvent precipitation is the only practical means so far employed, but is costly and must usually be followed by spray or roller drying. Some attention has been directed to using the whole fermenter broth—for example, in oil-well drilling muds and edible syrups. Sugar syrups made by the addition of sucrose to *Leuconostoc* pure cultures form an effective way of conveying dextran into a variety of food products without the problem of prior separation.

Derivatives of current interest include the sulphuric polyesters, which have a heparin-like blood anticoagulant action; some of them have been shown recently to be suitable for clinical use. The carboxymethyl ethers are likely to have superior stabilizing powers compared with the neutral polysaccharides. Other ethers and mixed ether/esters have been described, of which the most interesting is the polymerizable allyl derivative. Attention has been directed to the importance of microbial polysaccharides in soil structure; but the exploitation of dextran in this field may have to follow the development of large-scale, low-cost crude dextrans, possibly from the direct fermentation of natural sugar juices.

The discussion at the meeting was opened by Dr. C. R. Ricketts, who said that he thought dextran production might be regarded as the dextran industry now that there are six or eight factories engaged in it. He thought that the present phase of 'tailoring' the molecules of dextran after its initial preparation would be followed by direct production, by fermentation, of the molecular size and form required. The work on the effect of addition of short-chain dextrans and of sugars to the fermentation mixture in modifying the dextran produced provides a fruitful field for simplification in manufacture of the kind suggested and might have an important effect on making preparations for clinical use.

In reply to a question by Mr. D. Armstrong why dextran of a molecular weight of sixty thousand is excreted by the kidney whereas albumin of similar molecular weight presumably is not, Dr. Fletcher said that molecular shape is also important in excretion and that albumin can be re-absorbed back from urine by the kidney whereas dextran cannot. Mr. A. L. Bacharach suggested that in practice this matter is approached empirically and is not based on purely physiological concepts. In commenting that Prof. Stacey's paper showed the advantages of ultrasonics in achieving uniformity of molecular size, Mr. H. F. Frost asked if this method is used commercially, and Mr. Lockwood replied that there has been difficulty in getting large ultrasonic units of suitable types but that they are now being employed. Dr. D. H. F. Clayson asked if the breakdown of dextran in the body is due to attack of the $(1 \rightarrow 6)$ linkages and, if so, could it be controlled by adding inhibitors such as amylase to the blood. Prof. Stacey replied that there is no knowledge yet on either of these points, for no enzymes which could break such linkages have been isolated from body fluids. An inquiry was made by Mr. H. J. Bunker as to the raw materials for the large-scale development of dextran to which Mr. Lockwood referred, and Prof. Stacey replied that any sugar material can be used, including dextrins, and that recent restrictions in production in the Jamaican sugar industry because of over-production suggest that even raw cane sugar might be available for the purpose. Cane sugar undoubtedly must be one of the most important raw materials of the future. Mr. J. Green asked Mr. Wilkinson what was his evidence for saying that the dextran should not have molecular weight above three hundred thousand for clinical use, and the latter said that above this value aggregation of red cells can be demonstrated and this is said to be undesirable; he thought that this tendency might well not be of great importance, since turbulence in the capillaries could be expected to overcome it.

THE SHIRLEY INSTITUTE

ANNUAL GENERAL MEETING

THE thirty-fourth annual general meeting of the British Cotton Industry Research Association was held at the Shirley Institute, Manchester, on December 10, 1953, under the presidency of the chairman of the Association, Mr. N. G. McCulloch. In his speech Mr. McCulloch referred particularly to the statutory levy that came into operation during 1953, as a result of which all cotton processors in Great Britain now contribute to the Institute and are eligible to take advantage of the services which the Institute offers. He hoped that all new members would take full advantage of this opportunity. Mr. McCulloch also emphasized that firms who process rayon and synthetic fibres are encouraged to continue in membership or become new members, since so much of the Institute's work is concerned with, or applicable to, these fibres as well as to cotton. The honorary treasurer of the Association, Mr. J. Lindley, also referred to the levy, and paid special tribute to the generous way in which the industry had responded to the appeal for funds which it had been necessary to make in order to tide the Institute over the period before the first collection of the levy.

Dr. F. C. Toy, director of research, presented his annual report and directed attention to the more important of the year's activities. He mentioned especially two essays in the educational field: the travelling exhibition of the Institute's work on sizing

and weaving, and a course of lectures on card-room planning which had been given at the Institute and attended by more than a hundred and fifty mill representatives. Dr. Toy referred to the importance of work proceeding on mixed fibres, particularly mixtures of natural and synthetic fibres such as cotton and nylon. All in all, he said, the year had been an exciting one, marked by advances on both the scientific and technological fronts.

In the laboratories, which were open for inspection after the meeting, many of the researches attracted particular attention. The most interesting exhibit for spinners was the 'Shirley opener', a machine which had already attracted considerable attention at the exhibition of textile machinery at Belle Vue, Manchester. Separating lint from trash aerodynamically, by the use of stream-line air flow, it saves space and time in the mill. For the more scientifically minded, an apparatus for examining stroboscopically the form of ballooning yarns on spinning machines and for measuring the tension was shown, as were various devices for following the movement of fibres during drafting and measuring the forces involved. In the experimental spinning-room there was further evidence of work designed to improve quality and productivity.

In the Weaving Department, the automatic size-box was on view. By the use of this device, which employs a new principle of control that is independent of such factors as the viscosity of the hot starch paste, or size, which is used for protecting the yarn in weaving, warp yarns can now be prepared for weaving in such a way that there is complete and automatic control. at the machine, of the amount of solid material applied to the yarn. The Institute has for many years concerned itself closely with the problem of finding sizes that give good performance in weaving and with analysing the effects of the lubrication and adhesion provided by the size ingredients, and more recently there has been particular emphasis on the relatively difficult problem of finding sizes for hydrophobic fibres such as nylon and 'Terylene'. A small-scale sizing equipment, in which all the variables are under control and on which small quantities of yarn can be sized rapidly, was shown.

The 'Shirley rayon loom', which has been designed to take account of all the physical and engineering knowledge that has been gained from researches into weaving and loom mechanisms over past years, could not be shown as it is still being developed in co-operation with a loom manufacturer. However, the separate mechanisms, some of which were also shown in the travelling weaving exhibition, were to be seen. These have been designed by physicists and engineers working together, and prototypes have been developed in the Engineering Department.

The staff of the Finishing Department were able to discuss with members their work on physical and chemical problems over a large field. The behaviour of pressure bowls during calendering and mangling has been examined in a preliminary manner photographically, and, in the calender, more carefully and accurately by a photoelastic technique which has given interesting results. The experimental calender and mangle constructed in the engineering shop were shown. The chemical engineering section of the Department is interested in two main problems: drying, with the emphasis on convection and suction dryers; and fluid flow with particular reference to the dyeing of closely wound packages. The experimental equipment in a new and well-equipped laboratory of this section was shown for the first time. Physicists and chemists shared in discussing with members the work on printing. The young science of rheology comes into its own in this branch of the textile industry, since the non-Newtonian materials used for printing on fabrics are used at a wide range of rates of shear. The chemists find great interest in the consideration of starches and gums used in printing pastes.

In the Rayon and Silk Departments two problems of great interest to the chemist are under consideration. In the Rayon Department, work has proceeded for some years on the fractionation of regenerated celluloses according to their molecular weight, using osmotic and viscometric methods for the determination of molecular weight, together with an ultra-centrifuge designed and built at the Institute. This work has now reached the interesting stage where the physical properties of fibres prepared from specific fractions are being examined. In the Silk Department, the recent rapid developments in paper chromatography have been of considerable help in the problem of elucidating protein structure, with particular reference to the main constituents of the silk fibres fibroin and sericin. The more chemically minded visitors also found plenty to interest them in the fundamental work of the Chemistry Department, where the particular interest for many years has been the light shed on the structure of cellulose by studies of its oxidation.

The Physics and Physical Testing Departments are now housed in the new building, completely occupied for the first time in April 1952; some members were still interested in the design of the building, and particularly in the disposal of services and the means adopted for ensuring controlled humidity and temperature throughout the laboratories. Many were interested in the activities of the Testing Department, for it is there that much of the work on quality control is carried out, and particularly in the design of instruments. It is there also that much of the programme on blended fibres will be done, since the accumulated knowledge on the structure and mechanics of textiles lies there. Much of the more fundamental work on the physical properties of textile materials is done in the Physics Department; but perhaps of greatest interest to visitors was the work on the 'barrier' properties of textiles. Textile materials are almost invariably used as a barrier to something; it may be to heat, light, sound, water, water vapour, etc. Much work has been done, and will continue to be done, on the production of textiles which allow the passage of water vapour but not of water. More recently work on the properties of textiles as a barrier to dirt has been started, and it is hoped that in time much information will be obtained on the mechanism of soiling. In the meantime, members showed interest in an apparatus which has been developed in the course of this work for the convenient and rapid measurement of atmospheric dirtiness. Not entirely dissociated from soiling is the topic of static electricity, its cause, formation and dissipation. This has been a subject of fundamental interest for some time, and the apparatus used was available for inspection.

Lastly, mention must be made of the work being done on the cotton fibre. In addition to the large amount of co-operative work with the Raw Cotton Commission, Empire Cotton Growing Corporation and other bodies, in which physical and practical tests of cotton, new and old, are carried out, there is

great interest at the Institute and in the industry in the question of instrumentation, and particularly the possibility of forecasting the spinning properties of cotton from physical measurements. Members could see a range of such instruments, including some of foreign manufacture and some made at the Institute. The problem is not an easy one, and indeed may not be completely soluble; but advance has been made, and broad differences in the spinning properties of cotton can now be detected rapidly with the aid of purely physical tests.

OBITUARIES

Prof. H. H. Dixon, F.R.S.

THE death of Prof. Henry H. Dixon on December 20 severs a link with a past generation of botanists and with a classic advance in botany. He was born on May 19, 1869. He was one of a family of seven brothers and two sisters; two of his brothers, and previously his father's brother, were university professors. He had a distinguished career as a student in Trinity College, Dublin, being a classical scholar of some note; he then added to his laurels by obtaining a natural science 'moderatorship', taking first-class honours, and continued his studies under Strasburger in Bonn, under whom he commenced research in the two major fields to which he contributed so much in later life.

Bonn was a centre of cytological work and, though it is often forgotten now, Dixon was a contributor of some note in the Strasburger school to the work then being done on meiosis. A later paper communicated to the Royal Irish Academy in 1895 was probably the first expression of the view that the appearance of bivalents is due to the approach together of chromosomes, rather than to the splitting of some pre-existent structure, thus giving the first indication of a 'reduction division'. His observation of "waves of nuclear division" passing across endosperm suggested a mitotic hormone, an observation which has yet to be investigated more fully.

Dixon's interest in cytology and his contributions to it were, however, completely overshadowed by the importance of his work on movements of water and on the status of water, or water relations, in the plant.

His life-long friendship with Prof. J. Joly had, as one of its fruits, the close collaboration between himself, a botanist, and a physicist, and from this emerged the classic theory, spoken of as the 'cohesion theory', to explain the rise of water (sap) in trees and other plants. This hypothesis was developed in the 1890's and extended by notable contributions on the cohesion of water and of sap and by a series of papers on the osmotic relations of plant tissues.

Dixon's originality of mind showed itself in many suggestions which were not followed up in the rather small School of Botany of Trinity College, Dublin. As early as 1892 he had shown how to grow seedlings in sterile culture, and foreshadowed, had the method been developed more fully, the tissue- and root-culture techniques so much used at the present time. He suggested the differential manometer for estimation of respiration-rates in 1902, though he did not develop it as a research instrument. Prof. Dixon also suggested (in a letter in *Nature*) the mutagenic effects to be expected of cosmic radiation, before Müller and the genetical world had come to accept or even consider this view.

In later years his work on transport of solutes and on permeability caused him to suggest hypotheses which, while not accepted later by himself or others, proved to be an effective stimulus both to his own student, Mason, and many other workers elsewhere.

Recognition of Prof. Dixon's qualities came relatively early; he succeeded to the chair of botany in Trinity College in 1904 and was elected to fellowship of the Royal Society in 1908. He was awarded the Boyle Medal of the Royal Dublin Society in 1917 and gave the Croonian Lecture before the Royal Society in 1937. He had been president of the International Botanical Congress and of the Royal Dublin Society, and also of Section K (Botany) of the British Association. He was an honorary fellow of Trinity College, Dublin, an honorary member of the American Society of Plant Physiologists, a Commissioner of Irish Lights and played an active part in many other national and international organizations.

The importance of the School of Botany in Trinity College, Dublin, under his guidance causes one to forget that the staff of this School during sixty years has been only two—the professor and his assistant. No memoir, however short, would be adequate if it referred merely to Prof. Dixon's academic distinction without mention of his very genial personality and of the atmosphere of the School of Botany in Trinity College, Dublin, which he created and which, unfortunately, owing to its small size, so comparatively few of the younger generation of botanists have been able to enjoy.

T. A. BENNET-CLARK

HENRY DIXON began his university course in natural science under two good men, E. P. Wright, Sir Almroth's uncle, and H. W. Mackintosh, a wonderful lecturer, who looked down his microscope and saw the marvellous works of his Creator. He knew and taught that life begins with a single cell and develops in an orderly manner.

Wright, systematist and traveller, enriched both the Herbarium, which housed Harvey's type specimens of algæ, and the lovely Botanic Gardens. Dixon, soon his successor, opened his own professorial sessions with an introduction to the microscope and went on to unicellular organisms. He illustrated the great ideas of evolution and heredity by precise studies in cytology and morphology. No one could escape a knowledge of bacterial and fungal infection, or of elementary ideas in general physiology.

It was my good fortune to begin under Wright and Mackintosh, and to be in Prof. Dixon's first class. I accordingly witnessed the development of his fine course, published as "Practical Plant Biology" (1922 and 1943). Years afterwards a distinguished surgeon told me that it was the first thing that had really made him think. For the practical classes, which might run to 150, about a dozen demonstrators were taken on.

The successes of later years stemmed from Dixon's careful planning of the School of Botany, opened in 1907, which replaced the few residential rooms in the Front Square. The new Herbarium was added in 1912. The moving of collections and elimination of insects was heavy work. Into the eight-acre Botanic Gardens, moved to Balls Bridge in 1806, Dixon had up to some twenty years ago introduced more than seven thousand species, including Arthur Kerr's notable collection of Siamese orchids which Sidney Wild, the head gardener, tended so sedulously.

No mention of the T.C.D. School would be complete without reference to the red-headed lad, Joe Murray, who appeared in 1905–6 and remained there until his death on January 24 of this year. With the professor, "Joe", Wild and Polly, head of the College groundsmen, I spent many happy years.

The delightful atmosphere of our chief's laboratory could be traced back to the home with his mother and sisters—enlivened by frequent visits from his brothers and their families. It was the same in his own home with his wife, who cared for him with such devotion. I recall his happiness when telling me that their three sons (all of whom have had distinguished careers) had never caused him one moment's anxiety. W. R. G. Atkins

Mr. R. S. Whipple

It was with a deep sense of loss that his large circle of friends heard of the death of Robert Stewart Whipple, which occurred at his home in Highgate Village on Sunday, December 13. His father, G. M. Whipple, was superintendent of the Kew Observatory, and was himself very interested in scientific instruments. Thus Whipple grew up with scientific instruments and acquired a love for them which coloured his whole life.

Whipple was educated at King's College School, Strand, and on leaving went in 1888 directly into the Kew Observatory, staying on for three years after his father's death in 1893 with his successor, Dr. Charles Chree. In 1896 for two years he was assistant manager to L. P. Casella, and then he joined the Cambridge Instrument Company, which Horace Darwin in partnership with A. G. Dew-Smith had founded in 1881. In 1909 Whipple and C. C. Mason became joint managing directors. Under their management the firm developed and acquired a high reputation for the quality of its products. Of these, mention may be made of the 'rocking-microtome', a piece of beautiful design by Sir Horace Darwin, and a range of temperature-measuring instruments. Whipple was responsible for the introduction of the Féry radiation recorder, of which the firm bought the rights for Great Britain. He himself designed an instrument for reading temperatures direct on the gas-scale; this is used largely to-day in industry as a sub-standard.

He retired from active management in 1935, but remained a director, and in 1939 was elected chairman of the Board; from this he retired in 1949 for reasons of health, but continued to take a keen interest in the firm. During all this time he took a great personal interest in the employees of the company, which they fully reciprocated, feeling that in him they had a sincere friend.

Whipple was a valued member of the societies connected with physics and a constant attendant at their meetings. He was a member of the Council of the Physical Society during 1909–14 and again during 1925–36, a vice-president from 1914 until 1916 and treasurer from 1925 until 1935. He was president of the Optical Society in 1920–22. He was a founder member of the Institute of Physics in 1920, and served on its Board for a total of twenty-one years between 1920 and 1945, and on its Finance Committee from 1945 onwards. His services in the cause of physics received their highest recognition in his election to the presidency of Section A (Mathematics and Physics) for the Dundee meeting of the British Association in 1939, which, however, was abandoned due to the outbreak of war—one of the few cases in which that honour has fallen to an industrialist.

Whipple was always interested in the history of science and was a collector of early scientific instruments; of these he built up a wonderful collection which he most generously presented to the University of Cambridge in 1944; but it was not until 1951 that a small building was provided for their display, and the Whipple Museum was opened by the Vice-Chancellor on May 5. Now that "History and Philosophy of Science" has (partly perhaps due to the inspiration of this Museum) been included as a half-subject in the Natural Sciences Tripos, candidates will find the study of the actual instruments, that this Museum affords, of very real help. When the plans for the new Science Laboratories at Cambridge are further advanced, it is to be hoped that a larger building will be found, in which, with the Whipple instruments as a nucleus, the great number of instruments that Dr. R. T. Gunther proved to exist in Cambridge by the collection he was able to get together in June 1936 will again be assembled to grow to a collection worthy of the University.

In addition to the instruments, Whipple gave his library of scientific books, which included many of the rare early ones. He hoped that these might eventually be housed near the instruments, so that an instrument and its description can be studied together.

He also handed to trustees a fund of £3,300—later increased to £8,300—to be used for the purchase of instruments and books.

Whipple was a man of wide interests and engaged in many activities, serving on many committees; these will miss his wise guidance and support—often of a substantial kind. He will long remain in the hearts of those who served with him.

In 1939 he was elected president of the Highgate Literary and Scientific Institution, into which he put new life by his energy and help, and it is now a strong society. Only a little more than a week before his death, he gave the sum of £5,000 to trustees to be used for the benefit of Highgate Village.

Whipple was a fine example of an English gentleman, upright and honourable, full of kindliness and sympathy, ready to help in any good cause and a man of wise counsel and sound common sense. He had great charm of manner which endeared him to all with whom he came into contact. He married Helen Muir, daughter of a Glasgow engineer and sister of James Muir, professor of natural philosophy in Glasgow; they celebrated their golden wedding in June 1953. Their son, George, is chairman and managing director of Messrs. Hilger and Watts, makers of optical scientific instruments, and a daughter, Ruth, is the wife of Prof. J. F. Young, professor of pathology in the University of Aberdeen.

R. S. Clay

We regret to announce the following deaths:

Mr. P. S. Ridsdale, director of the Charles Lathrop Pack Forestry Foundation, formerly editor of the *American Forestry Magazine* (1912–22) and of *Nature Magazine* (1923–37), on December 23, aged eighty-one.

Mr. H. W. J. Stone, honorary secretary and treasurer during 1933–45 of the Parliamentary Science Committee and editor of its publication *Science in Parliament*, on January 17, aged seventy-six.

NEWS and VIEWS

Royal Military College of Science: Prof. C. J. Tranter, O.B.E.

PROF. C. J. TRANTER has been appointed Bashforth professor of mathematical physics in the Royal Military College of Science, Shrivenham, in succession to Prof. O. G. Sutton, who vacated the chair recently on his appointment as director of the Meteorological Office. Prof. Tranter joined the Ballistics Directorate of the Research Department, Woolwich, in 1931 as a junior assistant, after taking his degree at Oxford, where he had been a mathematical scholar of Queen's College, and his career has been in government service throughout. He joined the Military College of Science, as it then was, in 1935 as senior lecturer in gunnery and mathematics, was promoted to assistant professor in 1941 and during the long illness of the late Prof. Wright was virtually in charge of the Gunnery and Mathematics Branch. Since 1945 he has been head of the Mathematics Branch, and in 1947, after the post-war reorganization of the College, was appointed associate professor of mathematics. During and since the Second World War, Dr. Tranter has been a member of several of the research committees of the Ministry of Supply, and he has published a considerable amount of work, mainly on the application of integral transforms to the boundary-value problems of mathematical physics. Prof. Tranter is a D.Sc. of Oxford and was made an O.B.E. in the Coronation honours list.

Agriculture in the University of Aberdeen: Prof. A. B. Stewart

DR. ALEXANDER BOYD STEWART has been appointed to the Strathcona–Fordyce chair of agriculture in the University of Aberdeen, in succession to Prof. T. L. Bywater, who has gone to the University of Leeds. Dr. Stewart was educated at Logie-Coldstone School, Robert Gordon's College and the University of Aberdeen, where he graduated M.A. in 1925, B.Sc. in chemistry with first-class honours in 1928, and Ph.D. in 1932. After graduating in pure science, Dr. Stewart studied under the late Prof. Hendrick, the first incumbent of the chair to which he now succeeds, and then proceeded to Zurich to work under the late Prof. Wiegner. Returning to Scotland in 1931, he was a research student at the Macaulay Institute for Soil Research and was appointed to the staff in 1932. As head of the Department of Soil Fertility at the Institute, Dr. Stewart developed and extended the work of field experimentation with special reference to the maintenance and improvement of soil fertility. In 1945 he was appointed deputy director of the Macaulay Institute and has since served on numerous technical committees. In 1945, he spent six months in India advising the Central Government on problems of soil fertility and crop production. In collaboration with Dr. F. N. Woodward and the late Mr. J. P. Maxton, he undertook during 1949–51 a survey of agricultural, forestry and fishery products, and their utilization in the United Kingdom. Dr. Stewart has given his services in an advisory capacity to the Forestry Commission and, during 1952, visited the United States of America as a guest speaker. The Macaulay Institute for Soil Research, in parting with him, rejoices in his appointment as a successor of the late Prof. James Hendrick, to whose energy and enthusiasm the foundation of the Institute in Aberdeen was due in large measure.

School of Physics in the University of Sydney

THE previous head of the School of Physics of the University of Sydney was Prof. O. U. Von Willer, who retired in 1946 having held the post for twenty-three years, and the chair was vacant for six years until September last year when Dr. Harry Messel was appointed as the new head. Prof. Messel graduated in Canada from the Royal Military College and Queen's University, Kingston, Ontario, with honours degrees in physics and mathematics, and then went for a year to Scotland (University of St. Andrews), carrying out postgraduate studies in mathematical physics. During the following three years, spent at the Institute for Advanced Studies, Dublin, he took a keen interest in cosmic ray theory, in particular the theory of cascade processes, and it was there that he succeeded in giving an analytical solution for the long-standing fluctuation problem in cascade theory. This work was followed by a series of papers in which he developed the mathematical theory of one- and three-dimensional cascade processes. After a year at Adelaide, South Australia, Prof. Messel was appointed to the chair at Sydney and took energetic steps to establish a large and flourishing research school, concentrating on experimental and theoretical studies of the cosmic radiation and on modern theoretical physics, especially nuclear theory.

Prof. Messel has been joined by Dr. E. P. George from London, who will look after the experimental programme; and further new appointments in the experimental team are Dr. A. J. Herz (London), Dr. D. D. Millar (Manchester) and Dr. H. D. Rathgeber (Melbourne), and, in the theoretical team, Dr. J. Blatt (Illinois, U.S.A.), Dr. S. T. Ma (National Research Council, Canada) and Dr. M. R. Schafroth (Liverpool). A number of further appointments will be made shortly, bringing the number of permanent academic staff in the School to twenty-one. Two students from universities in England are already in Sydney, completing their doctoral training, and a number of postdoctoral Fellows from overseas will be arriving early in the new year. To supplement the limited funds available for research from University sources, Prof. Messel has secured support from Australian business men, with the excellent result that £25,000 is available for research equipment this year, and a similar sum promised annually for the future. This has been secured by setting up a Nuclear Research Foundation within the University of Sydney, which allows private individuals and industries to become members. Experiments are planned on air-showers, underground cosmic rays and spectrum measurements. Theoretical investigations are planned on cascade phenomena, fundamental particles, solid state, etc.

South Wales Laboratories of the British Iron and Steel Research Association: Mr. S. S. Carlisle

WE regret that in *Nature* of January 30, p. 191, it was stated that Mr. D. Luther Phillips was being succeeded as head of the South Wales Laboratories of the British Iron and Steel Research Association by Dr. J. Pearson. This is incorrect; Dr. Pearson is head of the Chemistry Department of the Association and is temporarily taking over the duties of head of the Steel-making Division. Mr. Luther Phillips is being succeeded by Mr. S. S. Carlisle. Mr. Carlisle graduated at The Queen's University, Belfast (College of Technology), in electrical engineering and later continued his studies

at the College, being granted the degree of M.Sc. in 1942. During the course of higher study he was appointed a temporary lecturer in radio and radiophysics at the College. In 1942 he joined the staff of the Director of Scientific Research, Admiralty, and was stationed for four years on H.M.S. *Excellent*, Portsmouth, where he was engaged on the development and trials of radar and gun control equipment, being particularly concerned with the development of electrical predictors. In 1946 he joined the staff of the British Iron and Steel Research Association, and in 1947 was appointed head of the Instrument Section of the Physics Department. Mr. Carlisle has been closely associated with the industry's co-operative work on instrumentation, particularly that of open-hearth furnaces, which has placed Great Britain in the forefront of steelworks instrumentation practice. He is a member of the Council of the Society of Instrument Technology.

Training and Supply of Graduate Teachers in Mathematics and Science

In reply to a request in the House of Commons on January 21 for a statement on the report of the National Advisory Council on the Training and Supply of Teachers with particular reference to graduate teachers of mathematics and science, the Minister of Education, Miss F. Horsbrugh, stated that she accepts the broad conclusions of the report, and that she is consulting the other interests principally concerned to see how the needs of the schools for a better supply of these teachers can best be met. She will also be asking the local education authorities to ensure that the most effective use is made of the graduate teachers of science and mathematics available to them now and in the future.

Threat of Atomic Warfare

Readers of the *Bulletin of the Atomic Scientists* will have noticed that the hands of the clock which forms the distinctive coverpiece of the *Bulletin* have been moved forward so that now they stand at two minutes to midnight. This is to direct attention to the recent announcement that an atomic test involving both fission and thermonuclear reactions was conducted by the U.S.S.R. on August 12 and to warn members of all nations of the great danger of an untoward event acting as a trigger for the eruption of atomic or thermonuclear warfare. In an article in the October number of the *Bulletin* (9, 294; 1953) entitled "The Narrowing Way", the editor, Dr. E. Rabinowitch, expresses the apprehensions which many Americans feel. He considers that unless special care is taken it may only be a few more swings of the pendulum before atomic explosions strike midnight for Western civilization. In 1945 or 1946, he states, the elimination of atomic weapons from national arsenals through an international control mechanism, substituting mutual interdependence for mutual fear, had a slight chance of success, but it now has none and will not until the present cleavage of the world into two sharply opposed power camps disappears. Dr. Rabinowitch maintains that the Western countries are faced with the inevitable prospect of a "cold peace", precariously supported by a mutual threat of atomic and thermonuclear annihilation, and that in order to strengthen this peace it is necessary for the United States of America to create a powerful and universal fear of, and revulsion to, war by presenting to the world a sober account of the present, and reasonable estimate of the anticipated, destructive capacities of the atomic and thermonuclear weapons in American and other hands. In addition, aggression must be made clearly unprofitable, and, he states, American policy must be directed towards maintaining unity and collective security in the non-communist world.

Linen Industry Research Association: Report for 1953

The report of the Council of the Linen Industry Research Association for the year ended September 30, 1953 (pp. 20; from the Association, Belfast, 1953), records the completion of the post-war development programme of the Institute laid down in 1945. Membership of the Association now totals 285; but although the grant-earning income increased, the total income decreased slightly through a reduction in the grant from the Flax Development Committee and in the revenue from patents. Promising results have been obtained with a prototype stapling machine for flax fibre, of which the object is to improve levelness during preparing and dry spinning. Investigations continued on productivity in flax spinning, on the drafting of flax and rayon staple fibres on flax machinery with the object of improving the regularity of the yarns, on the elimination of shading effects in plain dyed rayon staple fabrics and on yarn friction. Advances have been made in the use of electronic irregularity testers for routine mill tests for the control of yarn quality, and of the 'Linra photoslubber' to locate the causes of faults in production. In fundamental work on the relation between yarn strength and cloth strength, tests have been completed for cloths ranging in weight from 7 to 12 oz./sq. yd. New instruments have been developed for studying the physical properties of size materials and correlating these properties with performance in the loom. Further advances have been made in producing the crease-resistant finish on linen fabrics, and bulk trials on finishing linen fabrics to improve the wearing qualities are in progress, while a wash-fast flameproof finish applied to linen fabrics has given satisfactory results under user conditions. In moving the adoption of the report and accounts at the annual general meeting on December 11, 1953, the chairman of the council, Mr. H. B. McCance, said that perhaps the greatest contribution the Association has made to the industry has been its unconscious education in the scientific approach, and he referred particularly to the flow of staff from the Research Association to member firms. The director, Dr. A. J. Turner, stressed the plea in the report for greater co-operation from member firms in putting their problems to the Association's staff. He also reported that the experimental work on bleaching linen yarn in package form has now reached the stage of industrial application.

Australian and New Zealand Association for the Advancement of Science

The report of the twenty-ninth meeting of the Australian and New Zealand Association for the Advancement of Science, held in Sydney during August 1952, edited by J. F. Kefford, has been published (Vol. 29; pp. 386. Sydney: Government Printer, 1953). It includes the presidential address of Sir Douglas Copland on "Authority and Control in a Free Society", and those of the presidents of the several sections, with lists of papers read to the sections and the report of the standing committee of Sections C (Geology) and P (Geography and Oceano-

graphy) on research on eustatic sea-levels in Australia and New Zealand during 1949–52. The sectional addresses include those of Prof. M. L. Oliphant on the research school of physical science in the Australian National University; Prof. A. K. Macbeth on some aspects of the chemistry of monocyclic terpenes; Prof. F. W. Whitehouse on the Mesozoic environments of Queensland; I. M. Mackerras on zoology and medicine; Hon. P. M. Hasluck on the future of the Australian aborigine; Prof. W. Prest on the future of private enterprise; Prof. H. H. Davis on the control of dynamic loading on machine components and structure; E. V. Keogh on virulence and infectivity; Dr. H. C. Forster's review of programmes for agricultural research in Australia; Dr. F. H. S. Roberts on host specificity of livestock parasites in Australia; Prof. V. J. Chapman on problems in ecological terminology; Prof. N. L. Edson on the metabolism of the sugar alcohols; and C. Rudduck on geography and national development. Also published is Dr. J. R. Price's Liversidge lecture on some recent developments in the study of the chemistry of Australian plant products.

Legumes in Agriculture

LEGUMES have been grown as crops for at least six thousand years, though the scientific explanation of their value was not discovered until late in the nineteenth century. How best to incorporate these important plants in the various agricultural systems of the present day is clearly a fundamental question, and, as a step towards providing an answer, the United Nations Food and Agriculture Organization has carried out a review of leguminous plants throughout the world. The report, published under the title "Legumes in Agriculture" (F.A.O. Agricultural Studies No. 21. Pp. 367. Rome: F.A.O.; London: H.M.S.O., 1953; 15*s.* or 3 dollars), is by R. O. Whyte, G. Nilsson-Leissner and H. C. Trumble. In temperate zones, with ample and well-distributed water supply, wild white clover has become the key factor in ley farming, with subterranean clover as an efficient counterpart in the pastures of South Australia. Little, however, is known regarding the use of legumes in tropical and sub-tropical regions, and literature on the subject is very meagre. In consequence, one of the most valuable parts of the publication is the section giving the results of a questionnaire sent out by the Organization during 1951 as to the occurrence and use of leguminous plants in these parts of the world. The information is conveniently reviewed on a geographical basis, and it may well be that further work on the adaptation and utilization of legumes in the tropics would best be organized on a regional basis. The chief limiting factors appear to be social and economic rather than lack of species, though there is great scope for selection and breeding within existing material. Further, it seems likely that the position of the leguminous crop in the agricultural system will differ from that in temperate lands, the trend being away from a mixed legume/grass association towards a separate but contiguous cultivation. The review should also be valuable as a book of reference, for it includes an alphabetical list of genera with notes on each, tables summarizing the characteristics of herbaceous and shrubby legumes and a bibliography.

A Coniferous Petrified Forest in Patagonia

Two species of fir cones, both of which have been named and incompletely described in earlier publications, are described with anatomical details by Mary Gordon Calder in "A Coniferous Petrified Forest in Patagonia" (Bull. Brit. Mus. (Nat. Hist.): Geol., **2**, No. 2, 97–138; 1953; 12*s.*). This account is welcome as a full description of a locality where the petrified tree trunks are said to be 100 m. long and 10 m. round; its petrified fir cones have sometimes been sliced, polished and shown in museums as things of beauty. The forest is probably of younger Mesozoic age and was overwhelmed by volcanic ash. Of the two species of cones, one, *Araucaria mirabilis*, is like the Australian *Araucaria bidwilli* but different from the South American species of to-day. Radish-like bodies associated with the cones are recognized as the seedling hypocotyls of an *Araucaria* of this group; they had previously been a mystery. The other cone, with the unfortunate name of *Pararaucaria*, has nothing to do with *Araucaria* but is apparently an extinct member of the Taxodiaceae, its characters being found scattered among the genera of to-day. It is interesting that this family is now absent from South America. It is good to see that two of the many fossil genera assigned to a position between *Araucaria* and *Pinus* have been removed.

Natural History of Bombed Sites

A RECENTLY published illustrated brochure summarizes in a convenient and popular manner the record of colonization of the bombed sites of London by plants and animals ("The Natural History of the City." By R. S. R. Fitter and J. E. Lousley. Pp. 36+13 plates+1 map. London: The Corporation of London, Guildhall, E.C.2; 1953. 2*s.* net). The introductory chapter is largely a very condensed historical summary of the natural history of the City. It is followed by accounts of the plants, arranged according to their mode of dispersal, and the animals the presence of which is not so obviously connected with the results of bombing. In an appendix all the recorded species are listed. Though the booklet is not intended as a scientific contribution, it gives a good deal of interesting data on ecology and rate of dispersal. Clearly the opportunities to study this unexpected and ill-gotten phase in the City's development will, it is hoped, not long remain; but it is still possible among the ruins to observe rarities in both the plant and animal kingdoms.

British Mammals

SINCE the discontinuation of *The Zoologist* in 1916, the study of mammals in Great Britain has been greatly handicapped by the lack of a specialist journal. It is hoped to remedy this deficiency by publishing in *Oryx* a regular section devoted to the natural history and conservation of British mammals. The twin aims of the section are well illustrated by two articles in the current issue of *Oryx*, one on the field study and identification of British bats, by Michael Blackmore, the other on the case for a close season for deer, by G. K. Whitehead (**2**, No. 3; November 1953). In addition, it is hoped to publish regularly short notes on matters of general rather than local interest, to review books on or largely devoted to British mammals, and to abstract from local natural history journals any papers or notes of more than local interest. Editors of local journals and secretaries of the mammal sections of local natural history societies and field clubs are invited to send to Mr. R. S. R. Fitter copies of their journals or reprints of any sections of articles relating to

mammals. The address is Drifts, Chinnor Hill, Oxford.

Speech for Deaf Children

Research in the Department of Education of the Deaf at the University of Manchester has shown that deaf children less than three years old can begin to learn to understand speech through lip-reading as a result of home training by their parents (*Mem. and Proc. Manchester Lit. and Phil. Soc.*, 1952–53). This has been reported by Prof. A. W. G. Ewing, director of the Department, who has discovered that a majority of pupils in schools for the deaf have been found to be deaf from before the age of two. Principles and methods have been evolved which constitute a genetic and simplified approach to speech for the deaf. Investigations which have been taking place over the past twenty-four years have shown that few children are totally deaf and suggest that special nursery schools should be an essential part of educational provision to prevent dumbness. A combination of lip-reading with the scientific use of modern group and individual hearing aids greatly facilitates the development of speech, language and social adequacy by pupils in schools for the deaf.

Boris Kidrich Institute of Nuclear Sciences, near Belgrade

The rapid growth in recent years of a network of scientific institutions throughout Yugoslavia and, in particular, the establishment and development during the past five years of the three major institutions, the Rudjer Boshkovich Institute at Zagreb, the Josef Stefan Physical Institute at Ljubljana and the Institute for the Research on the Structure of Matter at Vincha, near Belgrade, was largely due to the efforts of Boris Kidrich. He was a chemist by training, but he devoted himself, as statesman and economist, to the task of the social, economic and scientific development of his country. Boris Kidrich died on April 7, 1953, and in recognition of his work for science the general assembly of the Institute of Research on the Structure of Matter unanimously agreed on April 13 to rename the Institute as the Boris Kidrich Institute of Nuclear Sciences. Accordingly, Vol. 3 (August 1953) of the Institute's scientific publication, formerly *Recueil de Travaux de l'Institut de Recherches sur la Structure de la Matière*, bears the new title *Bulletin of the Institute of Nuclear Sciences "Boris Kidrich"*. In addition to a photograph of Boris Kidrich as frontispiece, it contains nineteen original scientific articles dealing mainly with instruments developed at the Institute for investigations in nuclear physics.

Geography: Journal of the Geographical Association

This year the Geographical Association celebrated the sixtieth anniversary of its founding (see *Nature*, January 16, p. 99), and the occasion also marks the diamond jubilee of the Association's quarterly journal, now called *Geography*. A special, enlarged jubilee issue has been published which contains several papers on the work and history of the Association by T. C. Warrington, H. J. Fleure, O. J. R. Howarth and others. Founded by B. B. Dickinson, H. J. Mackinder, A. J. Herbertson, H. R. Mill and others for furthering the study of geography on a scientific basis in schools and universities, the Association has grown to be an organization of several thousand members with branches in many countries. Its journal once chiefly contained papers on teaching and method, but now it has developed into a leading publication in geographical research. The Association has in turn moved its library from Oxford, Aberystwyth and Manchester, and is now, by courtesy of the City Corporation, housed in Sheffield in a branch of the City Library.

Ergonomics Research Society: Annual Conference

The fourth annual conference of the Ergonomics Research Society will be held at Ashorne Hill, near Leamington Spa, Warwickshire, during April 5–8, under the chairmanship of Sir Frederic Bartlett, formerly professor of experimental psychology in the University of Cambridge. The conference will be opened by Sir George Barnett, H.M. chief inspector of factories, and the speaker at the closing session will be Dr. Leonard Carmichael, secretary of the Smithsonian Institution, Washington, D.C. The annual general meeting of the Society will be held on April 6. The conference will be open to non-members of the Society on payment of a fee of 30*s*. All those wishing to attend the conference, whether members or otherwise, must complete an application form by March 29 and return it to K. F. H. Murrell, "Spinneys", Marlpit Lane, Redditch, Worcs, from whom further information can be obtained.

Acoustics of Orthoptera: Symposium near Paris

A symposium on the acoustics of Orthoptera, the first of its kind ever to be organized, will be held near Paris in the Laboratoire de Physiologie Acoustique, Institut National de la Recherche Agronomique, Jouy-en-Josas, Seine et Oise, during April 5–8. The fields to be covered will be as follows: acoustic emission in Orthoptera (standardization of definitions and of physical acoustics applied to the emissions, techniques of recording, techniques of physical analysis, mechanisms of emission, emission behaviour, and techniques of artificial reproduction of the sounds); acoustic reception in Orthoptera (physiological analysis of reception (action potentials) and reception behaviour); behaviour of Orthoptera under artificial acoustic stimuli; and bibliography. Besides the usual short papers and contributions, the following specialists will give general reviews on certain topics and reports on the work which is being done in their respective countries: Germany, Prof. H. Autrum (University of Würzburg) and Prof. W. Jacobs (University of Munich); Great Britain, Prof. R. J. Pumphrey (University of Liverpool); Italy, Prof. E. Benedetti (University of Parma); and United States, Prof. H. Frings (Pennsylvania State College). The languages for the symposium will be French, English, German and Russian. Further information can be obtained from the Laboratoire de Physiologie Acoustique at the above address.

Announcements

Prof. H. H. Read, professor of geology in the Imperial College of Science and Technology, London, and Prof. Louis Royer, professor of mineralogy and crystallography and dean of the Faculty of Sciences of the Institut d'Hygiène et de Médecine d'Outre-Mer de l'Afrique du Nord, have been elected *correspondants* for the Mineralogical Section of the Paris Academy of Sciences in succession to the late Prof. A. Bigot and Prof. P. Niggli.

The thirty-eighth Guthrie Lecture of the Physical Society will be given by Sir Geoffrey Taylor in the Science Museum, Exhibition Road, London, S.W.7,

on March 26 at 5 p.m., his subject being "Diffusion and Mass Transport in Tubes". The Lecture is open to the public.

Following the annual general meeting of the Textile Institute, Manchester, to be held at The Queen's University, Belfast, on April 30, Dr. D. A. Clibbens, until recently head of the Chemistry Division of the British Cotton Industry Research Association, will deliver the Mather Lecture for 1954, his subject being "Cellulose Chemistry and the Textile Industry". The Mather Lecture, first delivered in 1919, is held in memory of Sir William Mather, president of the Institute during 1915–17.

The Histochemical Society will meet at Atlantic City, New Jersey, during April 16–17, following the session of the American Society for Experimental Pathology. A feature of the meeting will be a symposium on "Basophil Components of Cytoplasm", to be held on the afternoon of April 16. Further information can be obtained from the secretary of the Society, Dr. R. D. Lillie, Department of Health, Education and Welfare, National Institutes of Health, Bethesda 14, Md.

A conference on "Unit Processes of Oxidation", arranged jointly by the Institution of Chemical Engineers, the Chemical Engineering Group of the Society of Chemical Industry, the Chemical Engineering Group of the Koninklijk Instituut van Ingenieurs (Royal Institution of Engineers) and the Section for Chemical Technology of the Koninklijke Nederlandse Chemische Vereniging (Royal Netherlands Chemical Society), will be held in The Hague during May 6–7, with a third day reserved for excursions. Particular stress will be laid on the chemical engineering aspects of unit processes of oxidation. The conference language will be English. Further information can be obtained from the secretary of the British organizing committee, R. C. Odams, Institution of Chemical Engineers, 56 Victoria Street, London, S.W.1.

The Spectrochemistry and Colorimetry Group of the Austrian Chemical Association is holding its fifth international colloquium in Gmunden (Salzkammergut) during August 30–September 3. As in former years, the colloquium will be divided into two parts, absorption and emission spectroscopy; for the former, the theme will be the application of molecular spectroscopy to the examination of technical artificial fibres, and for the latter, the discussion will deal chiefly with non-conductors and the alloys of copper. Interested organizations from other countries are invited to attend and should write before the end of March to Arbeitsgruppe für Spektrochemie und Kolorimetrie im VOCh, Wien IX, Sensengasse 2 (Institut für gerichtliche Medizin). Each national organization will be allowed to submit five papers, and short summaries of these should be sent in by May 30.

The Atomic Energy Research Establishment, Harwell, is holding a second radioisotope conference in Oxford during July 19–23. The conference will be concerned with medical applications (including therapy and diagnosis), biological applications (including agriculture and biochemistry), chemistry and metallurgy, and physics, engineering and industrial applications. The last date for applying for membership at the normal fee is February 28, after which a late fee will be payable. Application forms and further information can be obtained from the Conference Secretary, Second Radioisotope Conference, A.E.R.E., Harwell, Berks.

The second (October 1952; 18 papers), third (December 1952; 23 papers) and fourth (March 1953; 28 papers) lists of scientific reports produced by members of the Atomic Energy Research Establishment, Harwell, and now available for sale at H.M. Stationery Office are published in the *Atomic Scientists' Journal* (3, No. 1, 58; 1953). They include bibliographies on americium, fission, the electrostatic separation of minerals, and the drying of gases and determination of moisture in gases, and reports of symposia on thin films and the handling of radioactive and toxic substances. The reports bear dates between July 1949 and November 1952.

Applications are invited for Lady Tata Memorial Fund grants, scholarships or fellowships to scientific workers of any nationality for research on diseases of the blood, with special reference to leukæmia or any aspect of malignant disease connected with leukæmia, during the academic year beginning on October 1 next. Grants are made for research expenses; scholarships are awarded as personal remuneration, their normal value being £600 a year for whole-time research; and fellowships are for workers with considerable research experience, the stipend being £1,000 a year. Applications must be submitted before March 31, and the awards will be announced in June. Application forms and further information can be obtained from the Secretary of the (European) Scientific Advisory Committee, Lady Tata Memorial Trust, c/o Medical Research Council, 38 Old Queen Street, London, S.W.1.

The Medical Research Council is offering a number of fellowships for the academic year 1954–55, as follows: *Rockefeller travelling fellowships in medicine* (2,700 dollars a year, or 3,600 dollars for married men) for graduates resident in Great Britain with previous research experience in clinical medicine or surgery, or in some other branch of medical science, to work at a centre in the United States or elsewhere abroad before taking up positions for higher teaching or research in Britain; *Eli Lilly travelling fellowships in medicine*, of a similar nature to the Rockefeller awards; and *Dorothy Temple Cross research fellowships in tuberculosis* (£650 a year, or £900 for married men) for British subjects to devote themselves to the advancement of knowledge of tuberculosis at a centre outside Great Britain. All these fellowships carry, in addition, an allowance for travelling and other expenses. Application forms (to be returned by March 15) and further particulars can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, Westminster, S.W.1.

"Methods of Theoretical Physics", by Prof. P. M. Morse and Prof. H. Feshbach, was advertised in *Nature* of January 16, p. v. The McGraw-Hill Publishing Co., Ltd., McGraw-Hill House, London, E.C.4, has asked us to state that the price of these volumes is £6 each; Part 2 consists of pp. 998–1978 of the complete work.

Erratum.—In the communication "Distribution of Radio-Frequency Brightness across the Solar Disk and the Derivation of a Model Corona", by P. A. O'Brien and C. J. Bell, in *Nature*, January 30, p. 219, the units of the distance from the centre of the disk in the graph for $\lambda = 1{\cdot}4$ m. should be 0, 0·5, 1, 1·5 and not 0, 1, 2, 3 as printed.

EUROPEAN ASSOCIATION OF EXPLORATION GEOPHYSICISTS

MEETING IN MILAN

THE fifth meeting of the European Association of Exploration Geophysicists was held in Milan during December 2–5, when about a hundred and ten members were present, the president, D. T. Germain-Jones, being in the chair. After discussing affairs of business, the chairman announced the recent deaths of two founder members, M. Schlumberger and K. Röpke, and called the meeting to pay tribute to their memory: Marcel Schlumberger was internationally famous for his development of electrical measurements in boreholes which are, to-day, routine in the oil industry throughout the world; Karl Röpke was one of the early workers, under Prof. Mintrop, with the seismic refraction method of prospecting.

Of the twenty-two papers presented, eleven were on seismic, six on gravity, three on electrical, one on magnetic and one on general problems in exploration geophysics. R. Cassinis and E. Carabelli (Italy) opened with an account of a reflexion and refraction survey for thickness determination over the Dei Forni glacier in the Italian Alps. Such investigations have a direct bearing on the exploitation of hydro-electric power, largely for the distribution of water for farming purposes, and large-scale surveys have already been carried out over the Swiss and French glaciers. A most disconcerting feature is that the number of glacial reservoirs has notably decreased in the past few years. By way of extreme topographic contrast, T. F. Gaskell (Great Britain) described the measuring technique and the results of the refraction surveys in the Atlantic, Pacific and Indian Oceans as part of the scientific programme of H.M.S. *Challenger* during 1950–52. An account of this seismic work has recently been published[1].

Three papers related to velocity measurement. The first, by F. Haarstick (Germany), implied that seismic computers are too apt to use continuous velocity/depth functions even when finite velocity changes are known to exist; but, in the discussion, several speakers refuted such a sweeping assertion. J. G. Hagedoorn (Holland) compared the vertical velocity measurements in a borehole with the bedding velocities obtained by refraction, but pointed out that dispersion might be greater for the much greater travel distances of the refracted impulses and, therefore, that these impulses would travel with a lower frequency and higher velocity. This would invalidate to some extent any conclusions as to anisotropy, while another adverse factor is that it is not possible to say explicitly what thickness of the refractor is traversed by the refracted (actually diffracted) wave in the bedding direction. The third paper, by J. Cholet and H. Richard (France), approached this matter of anisotropy in a more direct way. They measured travel times along various paths inclined up to 50° with the vertical and showed that a coefficient of anisotropy of 1·09 for clays and sands would compensate for the discrepancies of travel time observed.

On the theoretical side, M. Matschinski (France) proposed a simple but sufficiently exact method of dealing with elastic hysteresis in the propagation of seismic waves with particular reference to absorption, while T. Krey (Germany) presented three-dimensional formulæ for the correction of the position of the reflector for any refraction to which the reflected wave had been subjected.

The drilling of shot holes often poses difficult mechanical problems depending on the softness or hardness of the formations, the tendency for the walls of the hole to cave in and the loss of fluid circulation. G. Muratori (Italy) discussed the overall practical aspects and design details of the drilling machinery adopted in these various conditions; they included drills operated by high-pressure water jet, conventional rotary and percussion drilling and the very efficient diesel hammer especially suitable for the gravels and boulders of the Po valley.

It may seem surprising that, after a generation of seismic prospecting, the mechanism of the explosion and energy transmission at a shot point are imperfectly understood. The difficulty lies in the large number of controlling factors and the well-known requirement that a set of shot-point conditions is not entirely reproducible for check purposes. This situation was rendered more complicated by V. Colledan and A. M. Selem (Italy), who demonstrated that, with equal weights of an ammonium nitrate dynamite (sismite) and a nitro-glycerine dynamite (GDIMT), reflexion responses were greater for the former despite its 30 per cent lower strength and lower detonation velocity than the latter. Other explosives were also used in the test; but conclusive results cannot be given until many more experiments have been done; the results will be of some importance, as the ammonium nitrate explosives are much safer to handle in some climatic conditions than the nitro-glycerines. The safety factor in seismic work was further discussed by E. Merlini and A. M. Selem (Italy) in cases where the detonator circuits pass close to power lines, electric railways or deep well casings. The induced potentials set up in certain types of ground, especially during electrical storms, might result in premature ignition of the explosive unless precautionary disposition of the detonator leads is resorted to.

The final paper in the seismic session, given by L. Solaini and G. Uglietti (Italy), described an electronic blaster with a codified radio transmission of the shot instant designed to prevent 'noise' which may impair the received signal when using other blasters; all the usual operations from stand-by to shot-instant transmission are automatically provided for.

Contributions to gravity interpretation were made by three members. A. Marussi (Italy) discussed the meaning of the second differential parameter and adduced formulæ relating it to the curvature and normal gravity derivatives. V. Baranov and J. Tassencourt (France) gave a mathematical exposition of certain approximations made in a paper on a practical method of calculating the vertical gradient which the first author had given at the Paris meeting of the Association. The vertical gradient and second derivative methods were applied by O. Rosenbach (Germany), who showed how it is possible to locate a well on the down-throw side of a fault, given the depth of the up-throw side, other geophysical methods having failed.

A most interesting account of gravity measurements in the northern Adriatic Sea was given by C. Morelli (Italy). Here a tele-controlled Western

gravity meter, enclosed in a bathysphere weighing about half a ton, is lowered to the sea-bed, its position being fixed by radar intersection from fixed reflectors on land and at sea. The accuracy of measurement is estimated to be ± 0·05 mgal. The technique is, of course, several years old, but an important refinement in the new equipment is the inclusion of a compensator for microseisms, or sea-bed movements of relatively long period.

The meeting devoted some little time to the important subject of terrestrial tidal variation of gravity in precision studies, and, as the past president of the Association, A. van Weelden, had played a big part in initiating world-wide experiments to improve our knowledge in this respect, he was invited to take the chair for this section of the meeting. C. Morelli (Italy) reported on an extension of his diurnal investigations discussed at the Paris meeting and showed that curves calculated for northern Italy, lat. 45° N., long. 12° E., are applicable for all longitudes if times are suitably corrected. The curves yield an accuracy of 0·01 mgal. within 2 deg. of latitude. Extension to 13 deg. beyond this range also gives the same accuracy on multiplying the amplitudes by a suitable factor. M. Cunietti and G. Inghilleri (Italy) provided a general analysis of the accuracy of the curves for any one station and proposed that the terrestrial tide be derived from an expression of the form:

$$\Delta g = F_1 \sin^2 \varphi + F_2 \sin 2\varphi + F_3,$$

where the constants, which are functions of the local hour angle and declination of the moon and sun, would be periodically determined and published. R. Tomaschek (Great Britain) discussed solutions which, by needing only little computing work by a survey party in the field, would avoid the necessity of making periodical calculations in a central institute. He advocated the use of permanent curves for the sun and the moon and a simplified current noon ephemeris of the moon.

J. Goguel (France) then reported the conclusions of the Tidal Committee, consisting of himself, C. Morelli and R. Tomaschek. They recommended publication in *Geophysical Prospecting*, the journal of the Association, of two kinds of tidal corrections for 1954, which should be tested by field parties as to their simplicity. The first kind consists of curves showing the continuous variation of the tidal forces for several selected latitudes, and the second consists of tables. Each is expressed by:

$$\Delta g = -A + N(\cos\varphi + \sin\varphi)\cos\varphi + S(\cos\varphi - \sin\varphi)\cos\varphi,$$

where φ is the latitude and N and S time functions of the moon and sun together. The tables are obtained by means of a tide predictor. By using a simple nomogram the tidal correction may be determined by means of N and S for any latitude.

C. Morelli and L. Sogaro (Italy) described the results of a magnetic survey designed to investigate the trend of the volcanic outcrops in the Lessini, Berici and Euganei uplands as they disappear beneath the Venetian plain towards the Adriatic Sea. Two branches are apparent, one towards Venice and the other towards Chioggia.

In the electrical section J. J. Breusse and G. Huot (France) illustrated how, in the course of exploring for water, four hundred depth measurements mapped the top of a clay formation underlying the alluvium of the Catania plain (Sicily). The map showed the presence of an old river valley system which was believed to be filled with permeable alluvium; five wells drilled over these channels were productive. The problem of electrical sounding in the case of dipping plane interfaces is usually approached through an approximate application of the electrical image method for horizontal interfaces. A few years ago, however, an exact but laborious solution of the general problem was formulated. This has recently been improved on by J. Chastenet de Gery and G. Kunetz (France), who illustrated their analysis with interpretation charts. A most informative paper was that given by J. L. Mathieu (France), who described the 'laterolog', a method for better recording of formation resistivity in boreholes. Here, a current of constant intensity is forced into the formation perpendicular to the wall of the hole as a sheet of predetermined thickness by means of a special electrode arrangement, the control system being automatic. The many advantages of the 'laterolog' over ordinary resistivity logs were explained and illustrated by numerous examples.

The one general paper, by O. Vecchia (Italy), discussed the application of electrical and seismic refraction measurements in the problem of building a subsidiary dam on the Lake of Molveno, near Venice. The depth to bedrock was given by refraction, while the permeable nature of the overlying detrital matter was determined by electrical measurements at a number of water-levels. The results showed that subterranean losses disappeared when the level of the lake was 160 ft. lower than normal.

The technical proceedings closed with three films: "Schlumberger Surveys", presented by courtesy of the Société de Prospection Électrique, Paris; and "Recording the Safe Way" and "Drilling the Safe Way", both by courtesy of the Society of Exploration Geophysicists, United States. A short report of the Committee on Safety, given by A. van Weelden, made it very clear that lively action has been and will be taken on this important facet of applied geophysics.

All the arrangements for the meeting were efficiently and generously made by A.G.I.P. Mineraria, which also organized a visit to their geological and geochemical laboratories and to a seismic party; here, a comparative demonstration of rotary and percussion drilling by winch and diesel hammer was most impressive. On the lighter side, sight-seeing tours were arranged by A.G.I.P. for members' wives and for members themselves when their otherwise arduous duties were over, and the Fondazione Ing. Lerici gave a cocktail party. The next meeting of the Association will be in Copenhagen in the late spring of this year.

T. C. RICHARDS

[1] *Nature*, **167**, 723 (1951), and **170**, 1010 (1952); *Petroleum Times*, **57**, No. 1470 (1953).

MATHEMATICAL ASSOCIATION

ANNUAL MEETING

THE annual meeting of the Mathematical Association was held at King's College, London, during January 4–5, with the president, Prof. T. A. A. Broadbent (Royal Naval College, Greenwich), in the chair. In his presidential address, "Printer's Ink and the Teacher", Prof. Broadbent, who has edited the *Mathematical Gazette* since 1930, drew on this experience to offer two main suggestions to the teacher of mathematics. First, mathematics is a language, the

language of abstract, rational thought, and the teacher who wishes to train his pupils in this language must first be master of his own mother-tongue ; good mathematics and clear, simple English go together. Secondly, the teacher must use periodical literature in mathematics to keep in touch with some part, however small, of current research, so as to be able to present school mathematics to his pupils as an essential element of a living, growing organism.

In the afternoon of January 4 the meeting discussed the report of the Association on the teaching of sixth-form geometry. The report recommends a first course, including all that can be regarded as suitable for every pupil who takes mathematics as a main subject after he begins to specialize in mathematics, science or engineering, and a second course, suitable only for mathematical specialists, in which the beginnings of abstract projective geometry could be studied, thus rendering less abrupt the transition from school geometry to university geometry. The discussion was opened by Prof. E. H. Neville (University of Reading), the chairman of the committee which drew up the report, and by Mr. H. Miller (Watford Boys' Grammar School). In the open discussion members recognized the high importance of the report, but suggested that some years would have to elapse before its recommendations could be digested and applied. In the evening of the same day, the principal of King's College, Mr. P. S. Noble, spoke on "Euclid the Artist". Mr. Noble, as a distinguished classical scholar, sees Greek geometry as an integral part of Greek thought and art, and, after sketching its growth from Thales to Apollonius, he compared mathematics with other typical products of the Greek genius, in its essential simplicity, logic and beauty. As a particular instance, a detailed comparison with Greek forensic oratory was drawn.

The proceedings on January 5 opened with a discussion between Mr. J. Kershaw (College of Building, Liverpool) and Dr. C. W. Jones (University of Liverpool) on "Numerical Analysis". Mr. Kershaw outlined a course in numerical analysis for engineers, and Dr. Jones commented on the points raised, the general content of the syllabus and details of method. This interchange of ideas proved very instructive, and the Association hopes to stage a more elaborate version of such a debate at a later meeting. Mr. C. T. Daltry (Institute of Education, London) spoke next on "Teaching through the Flash of Insight". There is a logico-psychological conflict in the learning of mathematics, which may be resolved through teaching in accordance with Nunn's doctrine of the growth of mathematics from problem to process. 'Gestalt' psychology suggests that the problem must be seen as a whole, with a structure transcending the related parts ; genuine learning ensues when this view of the problem leads to "the flash of insight". All teaching, said Mr. Daltry, must be directed to the encouragement of individual insight and personal creative activity.

A discussion on "Unified Mathematics as a Factor in Education" was opened in the afternoon of January 5 by Mr. K. R. Imeson (Sir Joseph Williamson's Mathematical School, Rochester), Miss W. A. Cooke (High School, Slough), Mr. K. B. Swaine (Yeovil School) and Miss K. M. Sowden (City of Bath Training College). 'Unified' mathematics may mean a combined course or a method of teaching. The speakers found the second aspect the more important, and suggested a number of topics which could be grouped around one fundamental mathematical principle. Other matters of debate were the provision of combined or separate text-books, and the relevance of the method to pupils at different stages. In the open debate, details were criticized, but there seemed to be no definite verdict in favour of the 'unified' course.

The last paper was given by Dr. E. A. Maxwell (Queens' College, Cambridge), on "The World Around Us", in which, by a survey of the "General Knowledge" questions set by the scholarship groups of the University of Cambridge during the past fifty years, he depicted the examiner as historian, artist and sociologist. Delicate textual criticism enabled Dr. Maxwell to make substantial contributions to the study of "Examino-Deuteronomy", "Examino-Genesis" and "Examino-Revelations".

The president of the Association for 1954 is Prof. W. V. D. Hodge, Lowndean professor of geometry in the University of Cambridge.

BROADCASTING AND TELEVISION IN GREAT BRITAIN

At the meeting of the Institution of Electrical Engineers on October 8, Mr. H. Bishop, director of technical services of the British Broadcasting Corporation, gave his inaugural address as president of the Institution for the current session. The major part of the address comprised a most useful and opportune review of the development of broadcasting and television with special reference to the services of the B.B.C., and to the need for international co-operation. While those engaged in most branches of engineering have much to gain by the exchange of information and experience with their contemporaries in other countries, the radio engineer has a special need for international agreement since radio wave propagation cannot be restricted to national boundaries.

In just over thirty years, broadcasting has been built up from nothing in all the important countries of the world ; and several international organizations are now constantly concerned in seeking solutions to the problems which accompany the development and operation of home and overseas services. These problems include the allocation of frequencies in parts of the radio spectrum long since overcrowded, and the application of standardization to facilities for the exchange of programmes and the control of interference.

Some idea of the complexity of the problem of broadcasting on low and medium frequencies, on which most national home services at present depend, may be gathered from figures given by Mr. Bishop illustrating the growth of broadcasting in Europe. In 1929 there were two hundred stations in operation occupying a band-width of 1,215 kc./s. : as a result of a European Regional Conference at Copenhagen, a 'plan' came into operation in 1950 under which 243 stations were allocated frequencies which filled the total available band of 1,215 kc./s. Three years later, the number of stations in operation had increased by 50 per cent ; and as a result, all stations, including those of the B.B.C. in Britain, are liable to suffer serious interference. An indication of the corresponding growth of world broadcasting is given by the fact that the total number of sound receivers in all countries rose from 29 million in 1929 to more

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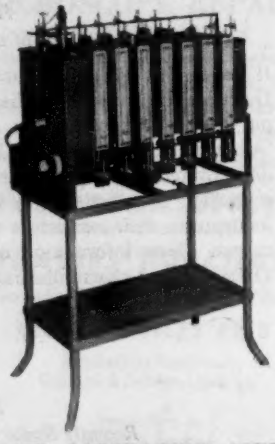

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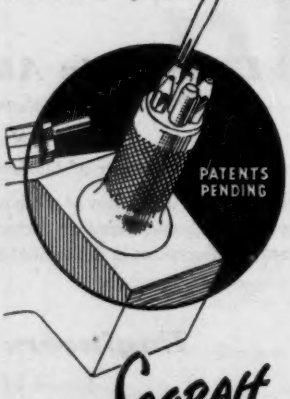

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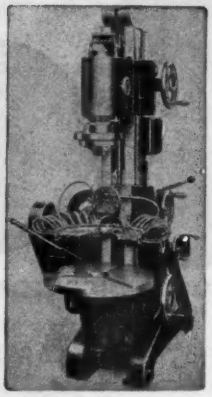

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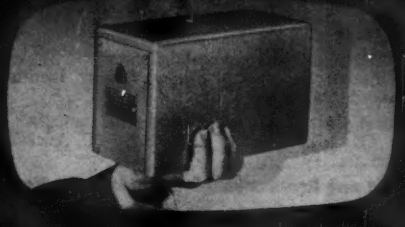

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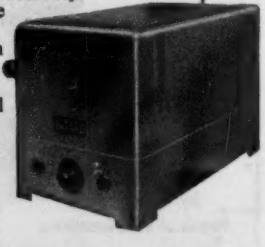

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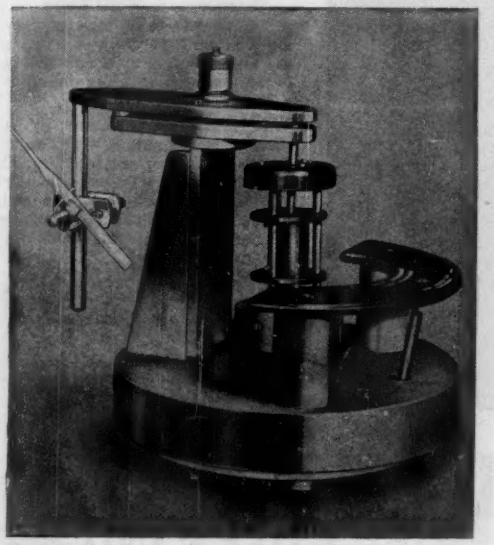

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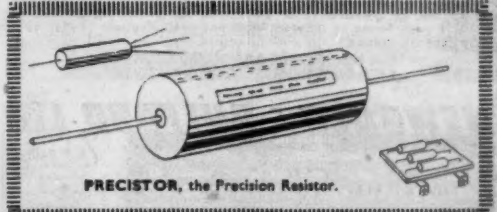

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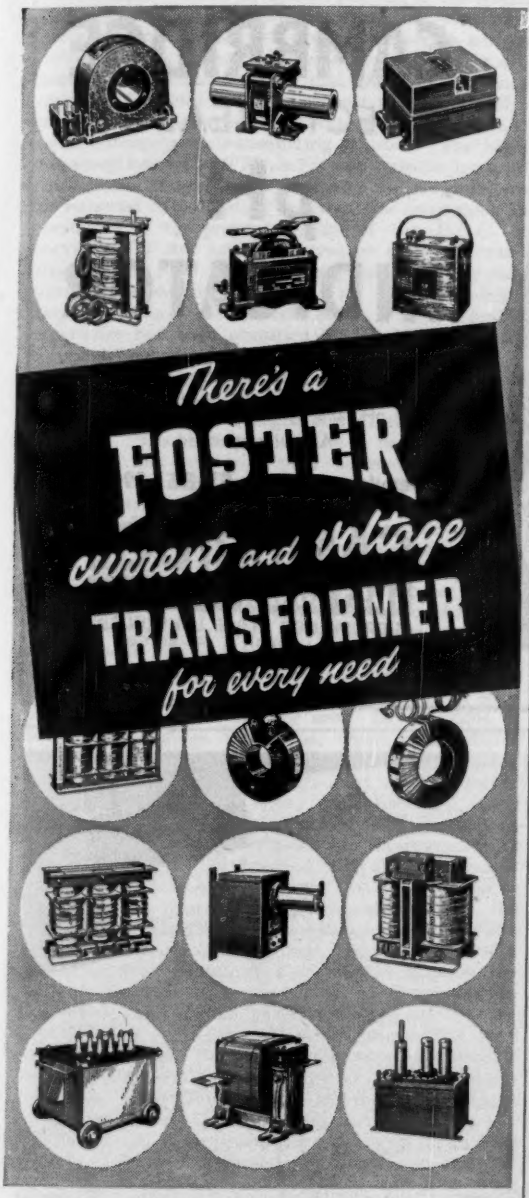

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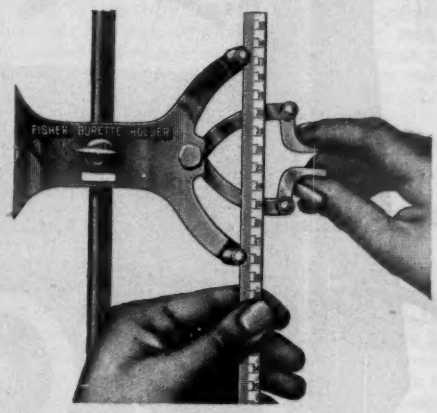

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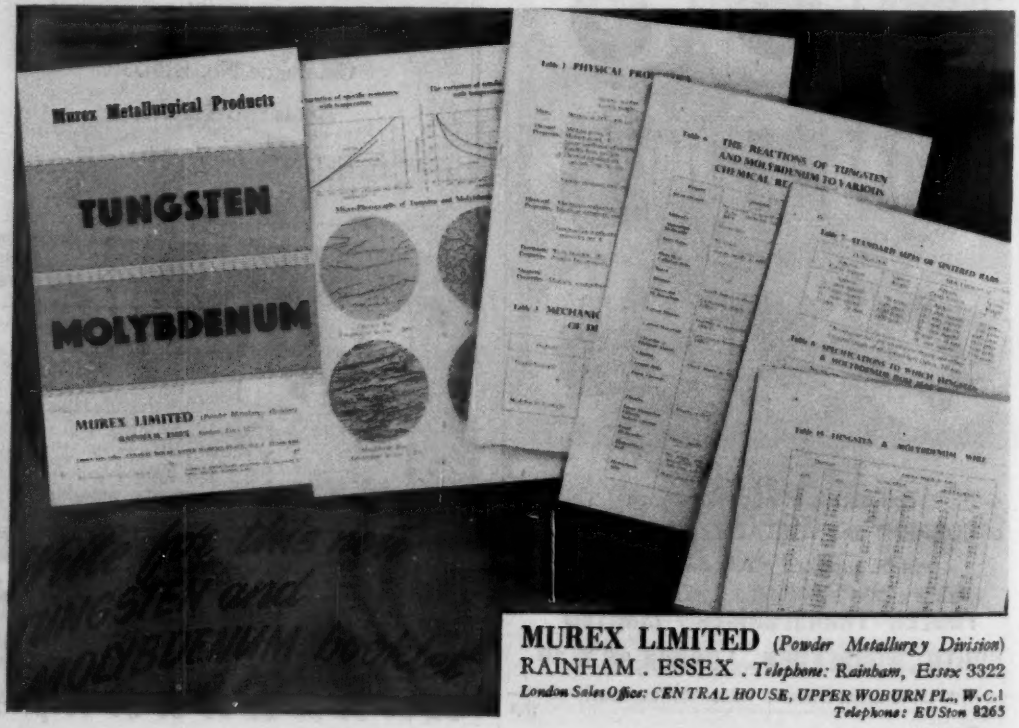

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than 200 million in 1953; the latter figure corresponds to one receiver for every twelve persons in the world.

The dearth of frequencies and the continued increase in the number of stations present a serious problem in the maintenance of a home sound broadcasting service in the low- and medium-frequency bands; and there is little prospect of resolving this problem by an increase in power or improvement in aerial efficiency at transmitting stations. The high-frequency band (3–30 Mc./s.) is not suitable for local services, and now has its own very serious problems for external broadcasting to countries overseas. In pursuance of the present policy of the B.B.C. of providing for the national coverage of three sound programmes, it is therefore proposed to inaugurate home broadcasting services in the very-high-frequency band of 88–95 Mc./s. Considerable experience has been obtained by the B.B.C. in this band with an experimental station at Wrotham in Kent, erected in 1949; and it is now planned to build fifty-one stations at nineteen locations to provide for the Home, Light and Third Programme Services. The building of these new very-high-frequency stations will take several years, and additional transmitters may be added later to complete the national coverage.

With reference to television broadcasting, Mr. Bishop first reviewed the considerations that resulted in the decision to reopen, in June 1946, the London television station, which provided a regular public service from November 1936 until the outbreak of war in September 1939. This has resulted in the development of the television service in Britain on the basis of the pre-war transmission standards of 405 lines, with double interlaced scanning at a picture frequency of 25 per sec. In the light of developments since that time, there is no doubt that this was the right decision. The subsequent installation of additional high- and medium-power transmitters in the United Kingdom has been accompanied by technical developments which have enabled a steady and considerable improvement in picture quality to be obtained with the band-width limitations imposed generally by the radio and cable links between the television transmitters and the studio at which the programme originates. While the present plans of the B.B.C. are concerned with providing national coverage to the extent of 98 per cent of the population for a single programme, the Corporation has also under consideration the need for providing an alternative television programme on a nation-wide basis. Such alternative services, together with any competitive programme service the Government may decide to introduce, will have to be transmitted in various bands of frequencies between 174 and 960 Mc./s. A large amount of research on various aspects of the use of these frequencies is in progress in anticipation of such developments. It is in these bands, also, that any system of colour television will have to be accommodated. In this connexion, Mr. Bishop stressed the importance of ensuring that any colour system introduced must be compatible with the present black-and-white system. This means that the colour transmissions must be such that they provide for the reproduction of a black-and-white picture on the two and a half million receivers already in use in Britain, without any modification of the band-width or other features of these receivers. It may, of course, be necessary to add an adaptor to such receivers to enable them to be tuned to the transmissions in the higher-frequency bands; and this and other matters are already receiving attention by those engaged in the radio receiver industry.

In the concluding portion of his address, Mr. Bishop referred to the fact that the rate of growth of membership of the Institution, which is about 38,000, appears to be decreasing. While this is not necessarily a bad thing, it might, he suggested, be associated with the problem of maintaining a sufficiency of recruits to the electrical engineering profession. He suggested that it is time to make a fresh assessment of the needs of the profession and the manner in which these could be met by stimulating the appropriate class of education in schools and universities.

NATIONAL RESEARCH DEVELOPMENT CORPORATION

ANNUAL REPORT FOR 1952–53

THE report and statement of accounts of the National Research Development Corporation, covering the year ended June 30, 1953*, is the last which will appear before the Corporation's borrowing powers expire at the end of next June. Although the Development of Inventions Act, 1948, which established the Corporation, empowered the Board of Trade, with the consent of the Treasury, to make advances of up to £5 millions for the capital expenditure of the Corporation in connexion with the development and exploitation of inventions, only 10 per cent of that amount has been used by the Corporation for the development of new inventions during its first four years. A statutory function of the Corporation is to secure, where the public interest requires, the development or exploitation of inventions resulting from public research, and of any other invention which it appears to the Corporation is not being, or is being insufficiently, developed or exploited. Of the fourteen development projects currently in hand, five are derived from private sources. The great majority of the public inventions either require no development or are of such a character that industry, when interested, is prepared to accept the risk of development.

The activities of the Corporation in connexion with requests for assistance for development during the past four years thus suggests that within its statutory responsibilities the need for assistance is much less than was anticipated when the Corporation was established. As a result of these four years of working the Corporation is now a party to more than two hundred and fifty licence agreements with industry in the United Kingdom or abroad, and to revenue-sharing agreements with universities, university research workers and industrial research associations. The administration of 2,224 patents and patent applications in the United Kingdom and overseas thereby involved is a continuing commitment for the Corporation in respect of wasting assets with a maximum life of about sixteen years. The Corporation is also required to seek to recover its expenditure by licensing firms engaged in the industry concerned so as to use the inventions which the Corporation administers. Revenue from recurrent royalties has steadily increased, that for 1953 being £21,204, whereas that from paid-up royalties

* National Research Corporation. Report and Statement of Accounts for the Year 1st July, 1952, to 30th June, 1953. Pp. ii+18. (London: H.M. Stationery Office, 1953.) 9d. net.

or premium royalties or options is necessarily irregular from year to year, and in 1953 was no more than £2,129 compared with £3,029 in 1950.

As regards development projects, electronic digital computers were still the largest single commitment. Commercial orders, including one for export, have been received for three of four large machines similar to that designed by Prof. F. C. Williams in the University of Manchester, and deliveries were scheduled to be made during 1953–54. The prototype of a smaller machine has been temporarily installed in the Mathematical Laboratory at Cambridge for trials. Development of the Packman potato harvester during 1952–53 was concentrated on the criteria necessary for a successful potato harvester as stated by the judges in the open competition of the Royal Agricultural Society of England. Development of the inventions in the field of hydrocarbon synthesis at the Imperial College of Science and Technology, London, proceeded without setbacks; but rapid progress was not at that time expected. Prototypes of a light steam-engine were being developed to suit the findings of a market survey in India and Pakistan. Development on both the aural microscope and the chick sexer was completed during the year, and a substantial number of chick sexers were sold in Britain and abroad.

Results of the pilot-scale production in East Africa of hecogenin from sisal juice have encouraged further contracts for supplies; the crude concentrate was being purified in the United Kingdom and pure hecogenin acetate was being made available for the synthesis of cortisone. Prototypes of the Burns inhaler for the administration of trilene and other volatile analgæsics were about to be delivered for clinical trials. Resin-based formulations containing insecticides have been the subject of patent applications in the United Kingdom and of overseas and licence agreements made with several British paint manufacturers. Commercially produced formulations are becoming available on an increasing scale. Increased interest in a group of some thirty inventions in the plastic structures field, which originated in the Royal Aircraft Establishment, Farnborough, is attributed to growing realization of the importance of phenolic-impregnated asbestos felts as constructional materials, and polyurethane and furan resins for foams and adhesives, respectively. A special study of the process of shock-curing of plastic laminates was being carried through so that the results could be made available to industry, and the construction by the Corporation of a plastic structures demonstration laboratory was proposed. The prototype of a novel machine for the liquefaction of atmospheric gases on a scale considerably smaller than that of conventional machines, invented at the University of Reading, was being built, and a programme of development of a regenerative system of mechanical transmission, known as the 'Gyreacta' system, has been inaugurated. This is of particular application to public-service vehicles.

Of the 692 inventions communicated to the Corporation during the year, 273 were from Government departments and research councils, 6 from industrial research associations, 16 from Commonwealth official organizations, 48 from universities and 314 from British private firms and individuals. Of the 257 patents or patent applications, the assignment or transfer of which to the Corporation was registered during the year, 185 were from Government departments and research councils, 22 from industrial research associations, 36 from universities and 11 from British private firms and individuals. Of the Corporation's total holdings of patents and patent applications at June 30, 1953, 501 were United Kingdom granted patents and 498 United Kingdom patent applications, the corresponding overseas figures being 227 and 998, respectively.

IMPERIAL FORESTRY INSTITUTE, OXFORD

ANNUAL REPORT FOR 1951–52

THE annual report of the Imperial Forestry Institute, University of Oxford, for 1951–52* shows that the Institute has expanded beyond all recognition from its early beginnings at the inception of the late Lord Lovat, the first chairman of the Forestry Commission. The idea then, as it still is, was to give postgraduate courses to forestry graduates who had been nominated as forestry probationers by the Colonial Office, and to offer refresher courses to members of the Colonial Services on leave. This latter course was attended during the year under review by sixteen forest officers from Nigeria (five), Gold Coast and Tanganyika Territory (two each), and Sierra Leone, Northern Rhodesia, Uganda, British Guiana, Trinidad, Fiji and Sarawak (one each). In addition, an Indian forest officer (Bengal) and one Pakistani forest officer (Punjab) attended the course arranged for them. As evidence of the wide nature of the courses offered at the Institute, five forest officers (Gold Coast, Nigeria, Trinidad and Sudan) attended a special aerial survey course during the Michaelmas term. In addition, the sylviculturist from the Agricultural Research Institute, Wad Medani, Sudan, and a German student from the forestry school of Göttingen attended the Institute for periods. It is of interest and importance to learn that nine students successfully sat the Final Honours School of Forestry. Of these, one Ceylon scholar took up a post in his country, another Gold Coast scholar took a post in the Gold Coast Forest Service, a third forestry scholar has returned to Uganda and two of the others obtained posts in the Colonial Forest Service.

The importance of the wide departure from the original conception of the Institute may lie in the future with the changing administrative policies in the British Colonies. Although little alluded to, forestry must play an important part if the forest services are eventually to be managed by the native administrations concerned. It is not possible, at present at any rate, to train fully the officers required for the higher forestry administrative posts in the Colonies. A final course in Europe may be regarded as indispensable to study European forest management which has been in force for so long a period. At the Institute such advantages are provided and other facilities are available to give the final training. For this reason alone the future importance of the Institute cannot be too strongly emphasized. The report deals fully with the various lecture courses given and the practical courses in the forests of France, Switzerland and Denmark, and also in Great

* The Imperial Forestry Institute, University of Oxford. Twenty-eighth Annual Report 1951–52. Pp. 28. (Oxford: Holywell Press, Ltd., 1953.)

Britain in both Forestry Commission areas and on private estates. Advantage can be taken of courses in every branch of forestry, including saw mills and utilization generally, soil science and other research.

The staff of the Institute, excluding the office and library members, now numbers fifteen, including Prof. H. G. Champion, the head of the Institute, with five others from university departments who assist in instructional work. An excellent reproduction of a drawing of the Institute building, by Alan Course of the *Oxford Mail*, is given as a frontispiece.

E. P. Stebbing

PRECAUTIONS IN THE USE OF IONIZING RADIATIONS IN INDUSTRY

THE Factory Department of the Ministry of Labour and National Service has produced an important and interesting booklet which gives a clear warning to the industrial worker using X-rays or the radiations from radioactive substances of the potential hazards and dangers to which he is exposed and of the precautions he needs to take to protect himself*. At the same time it illustrates the wide and rapid spread of the use of these radiations in industry for the examination, testing and improvement of products and processes. In the introduction to the booklet the numerous applications are outlined. These cover X-ray radiography of metals; X-ray fluoroscopic examination of manufactured articles; X-ray diffraction analysis of crystalline compounds; gamma radiography; elimination of static electricity; thickness control and measurement; and radioactive tracer methods to elucidate the mechanism of chemical, physical, engineering and biological processes. It is stated that no industrial processes coming under the Factories Act have as yet been reported in which neutrons, protons and deuterons, which are biologically very dangerous radiations, have been used; but the possibility that these particles may soon find suitable applications, particularly neutrons for radiography and diffraction, cannot be excluded.

It is emphasized in the section dealing with health hazards that experience so far shows that, with proper forethought and care, risks of impairment of the health of work-people in factories where ionizing radiations are used can be countered; but that complete immunity from harmful effects depends on an intelligent appreciation of the properties of the various radiations and of their potential damaging effects on the human body, and on vigilant attention being paid to the necessary precautions. This seemingly calls for specially and technically trained staff; in fact, to appreciate fully the detailed and valuable information given in the booklet the reader must have more than a nodding acquaintance with the terminology of radiation physics and chemistry.

In another section recommended maximum permissible dosage-rates, based mainly on the internationally agreed values adopted at the Sixth International Congress of Radiology 1950, are quoted and explained, and the latter half of the booklet is devoted to recommended precautions, both of a general nature and when using particular apparatus or methods. Under the heading of general precautions, the following categories are dealt with: planning and equipment; inhalation and ingestion precautions; supervision, training and monitoring; flow or dosimeter tests of workers' radiation exposures; and medical supervision. Special precautions are discussed separately for X-radiography, X-ray fluoroscopy, X-ray crystallography, gamma radiography, radioactive static eliminators, thickness gauges, radioactive tracer work and the handling of unsealed radioactive materials. The booklet ends with a valuable comprehensive bibliography of published memoranda on radiological hazards and protection.

The Factory Department of the Ministry of Labour and National Service is to be congratulated on the production of such an informative and timely booklet; it is a work which boldly presents the dangers of the new and powerful methods but yet, by indicating to industrialists how adequate precautions can be taken to safeguard their workers, wisely advocates the introduction and expansion of the use of ionizing radiations in industry.

* Ministry of Labour and National Service: Factory Department. Factory Form 324: Precautions in the Use of Ionising Radiations in Industry. Pp. ii+18. (London: H.M.S.O., 1953.) 2s. net.

ISOLATION AND PROPERTIES OF ALPHA-CORTICOTROPIN* FROM SHEEP PITUITARY GLANDS

By Prof. CHOH HAO LI, IRVING I. GESCHWIND, ANTHONY L. LEVY, J. IEUAN HARRIS, JONATHAN S. DIXON, NING G. PON and JERKER O. PORATH

Hormone Research Laboratory, Department of Biochemistry, University of California, Berkeley

IN an earlier communication[1] we described the preparation of a highly purified ACTH fraction (*E*) from an acid acetone extract of *sheep* pituitaries. We wish to report herewith the isolation from fraction *E*, without pepsin digestion, of a peptide (α-corticotropin) which behaves as a pure substance. This hormone is clinically active, and possesses adrenal-stimulating activity according to the results of standard bioassay procedures for adrenocortical function. While this work was in progress, the isolation and properties of corticotropins *B* and *A* from pig glands was reported by investigators from the Merck[2] and the Armour[3] laboratories, respectively.

The first step in a typical isolation of α-corticotropin is the precipitation at *p*H 9·3–9·4 of inactive material from a solution of fraction *E* in 50 per cent dioxane. The supernatant obtained from this step is further purified by zone electrophoresis on starch[4]. An electrophoretic pattern obtained in this manner is illustrated in Fig. 1. The active fraction is eluted from segments 5–7 and then chromatographed on 'Amberlite *XE*-97' resin under the conditions shown in Fig. 2. The contents of tubes 34–49 are combined, desalted, and submitted to 100 transfers in the all-glass counter-current distribution apparatus of Craig and Post[5] using a 2-butanol/0·5 per cent trichloro-

* In accordance with the suggestion of the Merck[2a] and Armour[3a] groups in designating pepsin-hydrolysed pig ACTH as corticotropin *B*, and the unhydrolysed hormone as corticotropin *A*, we have chosen to designate unhydrolysed ACTH obtained from sheep pituitaries as α-corticotropin, since many of its chemical and physicochemical characteristics differ from those described for corticotropin *A*.

acetic acid system (Fig. 3). The material in those tubes falling within the theoretical distribution curve for a partition coefficient of 3·20 is again desalted, and re-distributed (fifty transfers) in a 2-butanol/0·1 per cent trichloroacetic acid system (Fig. 4). Tubes 10–21, the contents of which follow the theoretical distribution curve for a partition coefficient of 0·41, yield α-corticotropin, which behaves as a single substance as judged by the following additional criteria of purity.

(*a*) *Zone electrophoresis.* Zone electrophoresis on starch at *p*H 7·0, 8·2, 9·1, 10·2 and 11·2 shows that α-corticotropin migrates as a single zone which contains the ACTH activity. (*b*) *Chromatography.* Elution analysis of α-corticotropin on '*XE*-97' resin with 0·08 *M* sodium bicarbonate gives a single peak. (*c*) *Carboxyl end-group analysis.* When α-corticotropin is treated with carboxypeptidase, a single C-terminal amino-acid, phenylalanine, is released. Kinetic experiments show further that phenylalanine, glutamic acid and leucine are released successively in amounts approaching equimolar proportions. These results suggest that α-corticotropin is composed of a single peptide chain, terminating in the sequence . . . leu.glu.phe. (*d*) *Chemical composition.* Amino-acid analyses of different preparations of α-corticotropin are consistent with the view that the product is a single chemical species. (*e*) *Biological assay.* Assay of the hormone in hypophysectomized rats reveals no evidence of contamination with either thyrotropin, somatotropin or gonadotropin; the local test in pigeons shows the absence of prolactin activity. Bioassay for melanophore-expanding activity in hypophysectomized *Rana pipiens* indicates that α-corticotropin possesses an intermedin contamination of less than 0·1 per cent. The adrenal-stimulating activity as estimated by the adrenal ascorbic acid depletion method[6] is approximately 150 I.U. per mgm. In hypophysectomized rats, injection of the preparation in beeswax–peanut oil suspension[7] causes hypertrophy of the adrenal cortex, as judged by histological changes and by adrenal weight increment.

The molar ratio of amino-acids in α-corticotropin is as follows: alanine 3, arginine 3, aspartic acid 2, glutamic acid 5, glycine 3, histidine 1, leucine 1, lysine 4, methionine 1, phenylalanine 3, proline 4, serine 3, tryptophan 1, tyrosine 2 and valine 3. Tyrosine and tryptophan were estimated spectrophotometrically[8], while the other amino-acids, including tyrosine, were estimated by quantitative paper chromatography of their dinitrophenyl derivatives[9]. The minimum molecular weight of α-corticotropin, computed from these analytical data, is approximately 4,500. A similar value may also be

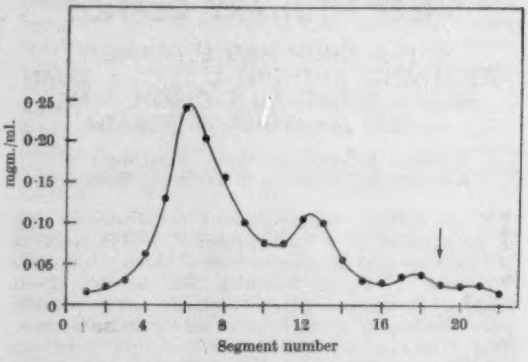

Fig. 1. Zone electrophoresis on starch of the dioxane supernatant of fraction *E*; 40-cm. trough, 1 cm. per segment. *p*H 11·1 (0·1 *M* Na_2CO_3), 200 volts, 16 hr.

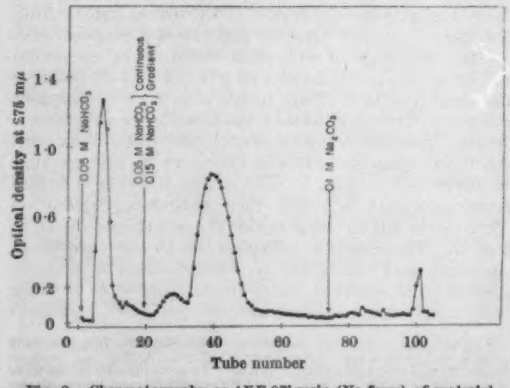

Fig. 2. Chromatography on '*XE*-97' resin (Na form) of material obtained from zone electrophoresis; 10 ml. per tube. The hormonal activity is located in tubes 34–49

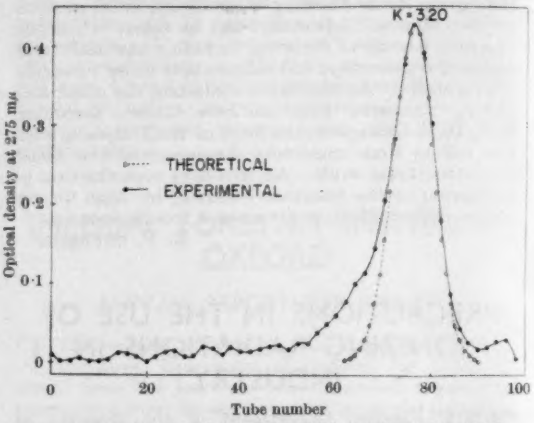

Fig. 3. Counter-current distribution (100 transfers) of material obtained from chromatography on '*XE*-97' resin. System: 2-butanol/0·5 per cent aqueous trichloroacetic acid

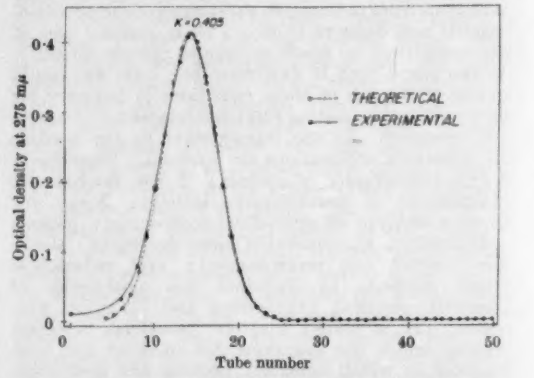

Fig. 4. Counter-current distribution (50 transfers) of α-corticotropin. System: 2-butanol/0·1 per cent aqueous trichloroacetic acid

calculated for the equivalent weight if it is assumed that one mole of phenylalanine is released per mole of peptide by the action of carboxypeptidase. The isoelectric point of α-corticotropin, estimated from zone electrophoresis on starch, is found to be *p*H 7·0.

It is of interest to note that certain properties of α-corticotropin are different from those reported for corticotropins *A* and *B*. For example, all three preparations differ markedly in amino-acid content[2a,2d]; furthermore, the partition coefficient of corticotropin *A* in a 2-butanol/0·2 per cent trichloroacetic acid system is 1·82 [2a], whereas that of α-corticotropin in the same system is 0·75. On the other hand, the C-terminal tripeptide sequence in α-corticotropin is identical with that reported for corticotropin *A* [2c], and both preparations possess comparable ascorbic acid depleting potencies.

This investigation was aided in part by grants from the U.S. Public Health Service and Eli Lilly and Company. We also wish to acknowledge the generous support of Merck and Co. and the Armour Laboratories during the early stages of this investigation.

[Nov. 27.

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EFFECTS OF ALPHA-(1-NAPHTHYLMETHYLSULPHIDE)-PROPIONIC ACID ON THE GROWTH OF EXCISED TOMATO ROOTS

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EARLIER work[1] has shown that the main axis meristems of excised tomato roots function only for a limited time when the roots are grown in constantly renewed modified[2] White's medium. This medium is of favourable *p*H, contains an adequate concentration of all the necessary nutrients and will promote over a prolonged period a high rate of increase in fresh root weight. The main axis, however, ceases to increase in length while the lateral roots are still growing rapidly. Further increase in fresh weight is then due to the growth of first-order laterals; at a later stage it is dependent upon the activity of second- and third-order lateral meristems. The duration of meristematic activity in individual root tips can be prolonged by repeatedly excising them from the root systems to which they have given rise[3]. This survival of activity in meristems excised at regular intervals can be further prolonged by low-intensity illumination of the cultures[4]. It is decreased by increasing the sucrose concentration in the medium[3] or by additions of β-indolylacetic acid (IAA) even at non-inhibitory concentrations[5].

On this and other evidence the hypothesis has been advanced[5] that the level of meristematic activity in roots is controlled by a hormone which at low concentration stimulates and at high concentration inhibits growth. Irreversible loss of meristematic activity is considered to result when the concentration of this hormone reaches a critical supra-optimal level. This hormone, or some precursor of it, is considered to be synthesized in the older parts of the root and transported to the main apex. It is postulated that a sub-optimal concentration of this hormone in the newly initiated meristem continuously increases as, during culture, the root system derived from the meristem increases in size.

The above hypothesis was supported by the findings that the response of root meristems to α - (1 - naphthylmethylsulphide) - propionic acid (NMSP)[6] changed during culture and that survival of meristems, subcultured in medium of high sucrose content, was enhanced by NMSP-treatment[5]. This substance, which conforms to McRae and Bonner's[7] criteria for anti-auxins, was shown by Åberg[8] to antagonize the inhibition of seedling root growth by 1-naphthaleneacetic acid, by 2 : 4 dichlorophenoxyacetic acid and to a lesser extent by β-indolylacetic acid.

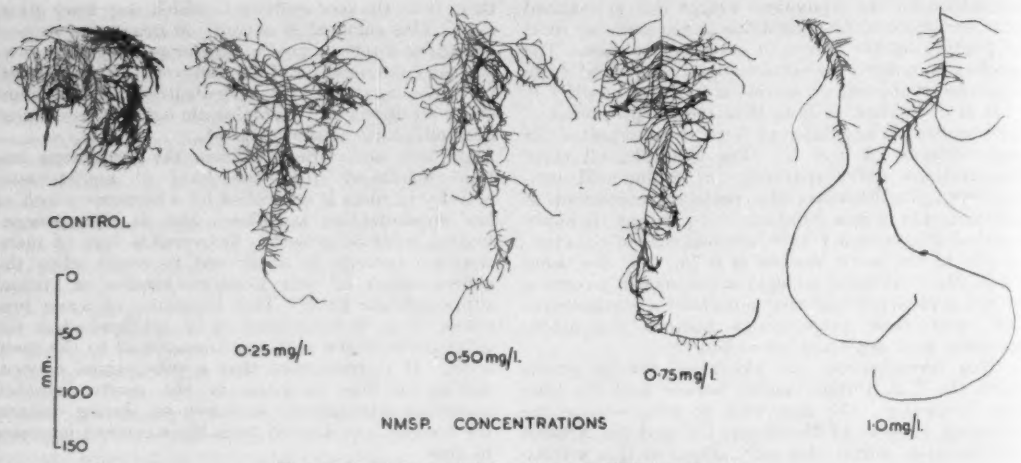
A study has now been made of the effects of NMSP on the growth of excised tomato roots (clone of Sutton's Best-of-All) in large volumes of medium (1,000 ml. per root). Modified White's medium in which iron (1·4 p.p.m.) was supplied as ferric citrate instead of as sulphate was used. Each flask was inoculated with a single 10-mm. root tip and incubated at 27° C. On the ninth day of culture a filter-sterilized, concentrated solution of NMSP was used for establishing in the medium concentrations ranging from 0·25 to 1·0 mgm./l. Roots were harvested after thirty-one days, by which time all roots, with the exception of some of those receiving 1·0 mgm./l. NMSP, had ceased main axis growth. Mean values for main axis lengths are shown in the accompanying table. The characteristic morphology of the control and NMSP-treated roots is illustrated by the accompanying photographs of representative roots.

At all NMSP concentrations the duration of main axis growth was prolonged beyond that of the controls. At 0·25 and 0·50 mgm./l., linear growth-rate of the main axis was initially increased, at higher concentrations decreased. During the first few days after its addition, 1·0 mgm./l. was clearly inhibitory

MAIN AXIS GROWTH OF EXCISED TOMATO ROOTS DURING 31 DAYS OF CULTURE

No. of cultures	Mgm./l. NMSP added on the ninth day of culture	Mean values for increase in main axis length (mm.) ± standard errors
10	Nil	171 ± 10
7	0·25	275 ± 15
6	0·50	305 ± 12
6	0·75	372 ± 26
8*	1·0	*422 ± 28

* Three roots the main axis length of which did not exceed the mean value for controls were omitted in calculating mean and standard error.



Photographs of representative control and NMSP-treated roots

and in some cases the main axis meristems did not survive this period. Excluding these roots (see footnote to the table) it was found that increase in NMSP concentration up to 1·0 mgm./l. caused a progressive increase in the average values for total main axis growth. At 0·50 and particularly at 0·25 mgm./l., growth of first-order lateral meristems was not inhibited and the duration of their growth was prolonged. This enhancement of lateral growth was most marked where only a limited extension of main axis growth occurred. At the higher NMSP concentrations, particularly at 1·0 mgm./l., lateral growth was checked. Youngest laterals were inhibited most strongly.

The effect of NMSP described above can be interpreted on the basis that it acts by antagonizing a natural hormone present in the root meristems. The higher concentrations are considered to induce a sub-optimal effective hormone-level in the meristems, thereby lowering the growth-rate but most effectively prolonging the duration of activity of individual meristems. The lower concentrations are considered to reduce the supra-optimal hormone concentration, developed during the first nine days of culture, to one nearer, but still probably above, the optimum. They therefore increase growth-rate but are less effective in prolonging the duration of meristematic activity. Lateral meristems, having a lower hormone content than the main axis meristems, are almost completely inhibited by NMSP concentrations which permit main axis growth. Cessation of main axis growth in the control roots and in roots treated with the lower concentrations is considered to result from the development, as growth proceeds, of a critical supra-optimal hormone concentration; inhibition of lateral growth in high NMSP concentration is regarded as due to a lowering of the effective hormone concentration in the lateral meristem to a critical sub-optimal level.

Elsewhere[5] it has been shown that β-indolylacetonitrile (IAN), at concentrations causing up to 50 per cent inhibition of main axis growth, does not markedly affect the duration of activity of meristems repeatedly subcultured. Evidence has also been obtained that the effects of NMSP on meristematic activity cannot be explained in terms of an NMSP–IAA antagonism[5]. The view is therefore advanced that a natural hormone, other than β-indolylacetic acid or β-indolylacetonitrile, controls the activity of excised tomato root meristems grown under our conditions of culture. This emphasizes the interest which will be attached to studies involving the other growth regulators the presence of which in roots has been revealed by recent chromatographic work[8].

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A LARGE HIGH-PRESSURE ULTRAFILTER

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ULTRAFILTRATION is a useful technique for concentrating weak solutions of proteins. The process is essentially simple and should avoid the partial loss of material frequently incurred by the use of chemical methods. Unfortunately, the rate of concentration is often too slow to be of much value, especially with labile material.

An ultrafilter has been designed for the rapid concentration of bacterial toxins and might be found useful in other fields where highly concentrated solutions of proteins are required. The apparatus has a total capacity of 15 litres and a filter area of 400 sq. cm. Ultrafiltration through a collodion membrane is carried out under nitrogen at a pressure of 300 lb. per sq. inch. The membrane is supported on a flat smooth porous tile, which in turn rests on a perforated steel plate. The ultrafiltrate is collected in a flask beneath the filter.

Construction. The filter consists of a cylinder of $\frac{3}{8}$-in. mild steel, 12 in. high, $9\frac{7}{8}$ in. internal diameter. Two flanges, one at the top, one at the bottom, each $1\frac{3}{8}$ in. wide, are tapped to receive sixteen $\frac{1}{2}$-in. bolts

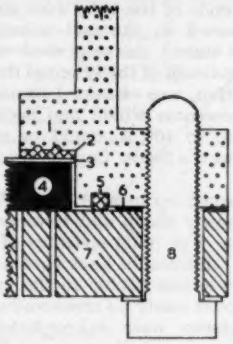

Fig. 1. 1, Flange. 2, Rubber washer. 3, Collodion membrane. 4, Porous tile. 5, Rubber ring. 6, Metal washer. 7, Perforated base plate. 8, Bolt

which secure the lid and base plate. The lid of $\frac{3}{4}$-in. steel is drilled to accommodate a pressure gauge, a safety valve, a release valve and an inlet valve bearing a union for the nitrogen pipe. Between the lid and the rim, which are both grooved, an $\frac{1}{4}$-in. rubber washer is fitted.

The construction of the bottom of the apparatus is shown in Fig. 1. The base plate (7) of $\frac{3}{4}$-in. steel is drilled with nine concentric rings of holes 0·1 in. in diameter and half an inch apart. The porous tile (4) of white unglazed porcelain, ground flat on both sides, is approximately $\frac{7}{16}$ in. thick. Tightening the bottom bolts presses the edge of the membrane (3) between the tile (4) and a rubber washer $\frac{1}{8}$ in. thick (2) resting on a grooved flange (1); this provides a leak-proof seal. The rubber washer is compressed to about half its thickness; this allows some latitude in the thickness of the tile. Excessive pressure on the tile is prevented by the metal washer (6). The bolts were screwed up as tightly as possible. A hard rubber ring (5) which projects from a rectangular groove prevents any leakage of ultrafiltrate. The whole apparatus is tin-plated to prevent corrosion.

Preparation of the Membrane. A sheet of 'Cellophane' (British Cellophane, Ltd., P.T. 300) is stretched over a square of plate glass and fixed to the under-side with 'Cellotape'. The glass sheet is placed on a tray, 'Cellophane' surface uppermost, and an 8 per cent solution of collodion in glacial acetic acid (I.C.I.) is poured on to it. When the surface has been covered the glass is picked up with the aid of rubber gloves and drained from each corner in turn until most of the surplus collodion has been removed. It is then plunged into cold water. After a few minutes the 'Cellophane' sheet can be cut away from the edge of the glass. The collodion membrane can then be separated easily from the 'Cellophane' sheet. It is allowed to harden in running water over-night. After hardening, the membrane is found to have one smooth surface and the other slightly uneven, and it is placed on the tile smooth side upwards and trimmed to fit. Two litres of 0·5 per cent solution of sodium bicarbonate are then forced through the membrane under a pressure of 100 lb. per sq. in. to remove any traces of acid.

Six membranes prepared in succession by this method have all proved to be satisfactory.

Performance. Under a pressure of 300 lb. per sq. in., the bicarbonate solution passed through the membrane at the rate of approximately 10 litres an hour. At the same pressure, 2 litres of a solution of horse hæmoglobin in distilled water (40 mgm. per 100 ml.) were reduced practically to dryness in $2\frac{1}{2}$ hr. The hæmoglobin remained on the surface of the membrane as a thick film, too dry to flow. 3 ml. of the ultrafiltrate gave no reaction to the benzidine test. 3 ml. of a 1/5,000 dilution of the original hæmoglobin solution gave a positive reaction. This showed that less than 1/5,000 part of the hæmoglobin had passed through the membrane.

In five successive tests no hæmoglobin was detected in the ultrafiltrate. On three of these occasions a hand spectroscope was used, on two the benzidine test. On another occasion 1,200 ml. of papain digest broth containing *Clostridium welchii* epsilon toxin was reduced in $2\frac{1}{2}$ hr. to approximately 10 ml. of fluid which had the consistency of treacle. The ultrafiltrate was non-toxic; but the 'treacle' was intensely toxic.

To maintain rapid rates of filtration it was necessary to rock the apparatus gently to and fro every 15 min. to avoid premature accumulation of highly concentrated material on the surface of the membrane. This could probably be avoided by the incorporation of some form of stirrer.

The pressure fell during filtration by about 10 lb. every 30 min. This was of little importance with small volumes. For prolonged filtration it is hoped to fit an automatic release valve to keep the pressure constant at 300 lb. per sq. in.

The apparatus was made by Messrs. D. Mackay, Cambridge, and the tiles by Messrs. James Macintyre and Co., Ltd., Burslem. We owe thanks to many for useful suggestions, especially Mr. J. Welch, of Messrs. D. Mackay, and Mr. H. Proom, of the Wellcome Research Laboratories. [Oct. 21.

CRYSTALLINE SWELLING OF MONTMORILLONITE

Use of Electrolytes to control Swelling

HOFMANN, ENDELL AND WILM[1] first demonstrated that montmorillonite had a layer structure similar to mica but differed from it in that the interlayer distance was variable and dependent on water content. Many workers[2–6] have since verified this one-dimensional crystalline swelling and have shown that the exchangeable cations, situated between the silicate sheets, are largely responsible for swelling. Initially, swelling is a result of hydration of the cations[4]; but later it proceeds in 3-A. steps[6]. All the above workers are in agreement that with calcium-montmorillonite the interlayer swelling does not proceed beyond 20 A., but Mering[7] and Barshad[8] failed to confirm the report of Hofmann *et al.*[2] that sodium-montmorillonite gave a spacing very much greater than 30 A. in water. This record is probably to be interpreted as failure to observe a definite diffraction line up to the low-angle cut-off of the camera. Mering concluded that crystalline swelling ceased at 20 A., when the (001) spacing became very diffuse.

In contrast to its observed crystalline swelling, sodium-montmorillonite will swell to twenty times its own volume in water[7]. Also in contrast to the limited crystalline swelling are the physico-chemical measurements on sodium-montmorillonite[9,10], which suggest that in suspensions and gels the particles are the fundamental silicate sheets, 10 A. thick.

During work by one of us (J. P. Q.), with Dr. R. K. Schofield, on the permeability of clays to electrolytes, it became desirable to know the (001) spacing of montmorillonite in sodium chloride and calcium chloride solutions of various concentrations. X-ray diffraction measurements made on montmorillonite while immersed in these solutions are given in the accompanying table.

(001) Spacing of Sodium-Montmorillonite immersed in Sodium Chloride

NaCl normality	$d_{(001)}$ (in A.)
4	15·4
1	18·7
0·5	18·9
0·31	40

(001) Spacing of Calcium-Montmorillonite immersed in Calcium Chloride

$CaCl_2$ normality	$d_{(001)}$ (in A.)
8	15·3
2	18·7
0·2	19·0
water	19·0

The observation of a definite spacing at 40 A. is of interest as it indicates that crystalline swelling can proceed beyond 20 A. The results also show that electrolytes can be used as a convenient means of controlling swelling in the range of high water content.

Mering[7] has shown that almost all the macroscopic swelling of montmorillonite takes place at water contents equivalent to a relative humidity of greater than 99 per cent. To control the water content and measure the X-ray spacing in this range by direct methods would involve very precise temperature control.

This work was carried out at Rothamsted Experimental Station, Harpenden, Herts, during the tenure, by both authors, of C.S.I.R.O. (Australia) studentships.

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Manner of Swelling of Montmorillonite

The use of electrolytes as a means of controlling the swelling of montmorillonite was so convenient that a study was made of the variation of (001) spacing with electrolyte concentration for montmorillonite saturated with the following cations: $H^+(H_3O^+)$, Li^+, Na^+, K^+, NH_4^+, Cs^+, Mg^{++}, Ca^{++}, Ba^{++}, $Cu(NH_3)_4^{++}$, Al^{3+}.

An oriented flake[1] of sodium-montmorillonite (Wyoming bentonite) about 0·03 mm. thick was placed in a plastic tube of 0·3 mm. internal diameter. The flake was saturated with the desired cation by passing a strong (1–4 *N*) salt solution through the plastic tube. Then a solution of the same salt at the required concentration was passed through the tube and finally the ends of the tube were sealed, keeping the flake immersed in the salt solution. Except where otherwise stated, the salts used were chlorides.

A diffraction pattern of the oriented flake, immersed in the salt solution, was obtained by using a curved crystal monochromator which had been modified so that spacings up to 400 A. could be recorded on a flat film placed at the focus. Copper $K\alpha$ radiation was used.

For (001) spacings up to 22 A., the (001) diffraction lines were relatively sharp and formed a rational or irrational series. For (001) spacings of greater than 30 A., the (001) diffraction lines became diffuse with only one or two orders visible to the eye. Although the (001) line could easily be measured visually, these diffraction patterns were microphotometered and interpreted using a one-dimensional Fourier transform method[2].

According to their effect on the swelling of montmorillonite the cations may be grouped as follows.

H^+, Li^+: in 4 *N* solutions, the (001) spacing was 15·4 A. With decreasing concentrations, the (001) spacing increased, giving a rational series of (001) lines at 19 A. and 22·5 A., indicating that the expansion was stepwise. At 0·5 *N* the spacing jumped from 22·5 A. to 36 A. and the diffraction pattern became diffuse. The interlayer spacing then increased continuously, being linear with respect to $1/\sqrt{N}$, so that at 0·01 *N* the spacing was about 140 A. The diffuse nature of the diffraction pattern prevented observations beyond this point with the equipment available.

Experiments with acid-montmorillonite had to be completed within several hours of bringing the montmorillonite into contact with hydrochloric acid, as after this time the spacing changed. In concentrations of less than 0·5 *N* hydrochloric acid the spacing collapsed to 22·5 A. within a day. This change is almost certainly due to acid attack on the clay releasing Al^{3+} ions[3], and it is consistent with the anomalous swelling properties of acid-montmorillonite[4].

Na^+: In sodium chloride the montmorillonite departed from the above behaviour in that stepwise swelling proceeded only to 19 A. and then, at 0·3 *N*, the spacing jumped to 40 A. In more dilute solutions it followed the same line as H^+ and Li^+. The variation of the interplanar spacing with $1/\sqrt{N}$ for sodium chloride solutions is shown in Fig. 1.

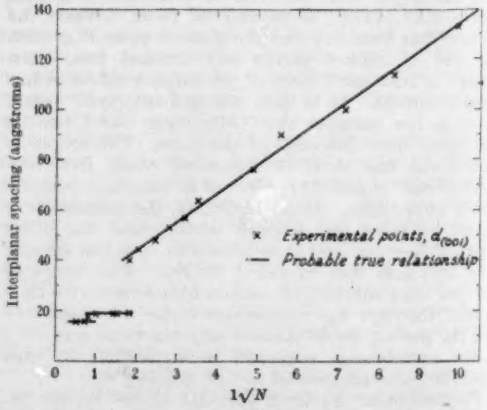

Fig. 1. Lattice expansion of sodium-montmorillonite in sodium chloride solutions

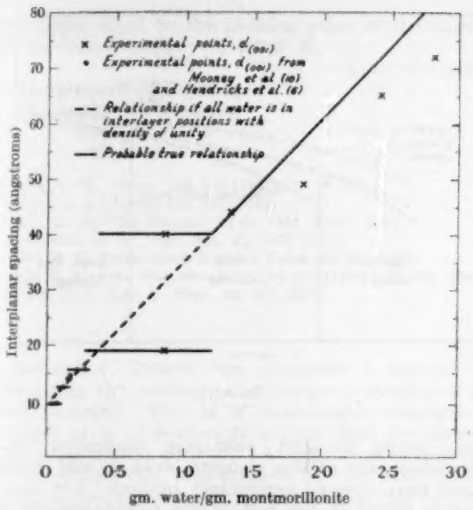

Fig. 2. Lattice expansion of sodium-montmorillonite as a function of water content

In sodium sulphate solutions swelling proceeded in the same manner, the spacings being the same as those of more dilute sodium chloride solutions.

Experiments with hectorite, from Hector, California, U.S.A., and montmorillonite, from Redhill, England, indicated that in sodium chloride solutions their behaviour was similar to that of Wyoming montmorillonite.

K^+, NH_4^+, Cs^+: The spacing of montmorillonite saturated with these cations normally did not proceed beyond 15 A., even in water. However, by expanding the montmorillonite in sodium chloride and then replacing the sodium ions by potassium ions, using weak potassium chloride solutions, large spacings were obtained with potassium-montmorillonite. Ammonium-montmorillonite behaved in the same way.

Mg^{++}, Ca^{++}, Ba^{++}, Al^{3+}: With these ions the spacing increased from 15 A. to a maximum of 19 A. with decreasing concentration.

$Cu(NH)_4^{++}$: Montmorillonite saturated with this ion gave a spacing of 12·4 A. which was independent of electrolyte concentration.

Fig. 2 shows the results obtained by adding known amounts of water to sodium-montmorillonite. It is evident that, within experimental error, which is largely due to the difficulty of obtaining equilibrium at such high relative humidities, most of the swelling of montmorillonite can be accounted for by lattice swelling. Between water contents of 0·37 and 1·19 gm./gm. clay, both 19-A. and 40-A. spacings are present, the former decreasing in number and the latter increasing with increasing water content. The 40 A. spacing gives a diffuse second-order diffraction line at 20 A., so that while the water content increases by three times the 19-A. line shifts very little in position but becomes diffuse. It was this behaviour that led Mering[3] to conclude that the interlayer distance did not increase beyond 20 A.

The above results suggest that the swelling of montmorillonite takes place in two rather distinct ways. First, below 22 A. the interlayer expansion is stepwise[1] and very dependent on the exchangeable cation[4]. For the monovalent cations the number of water layers taken up is directly related to the hydration energy of the cation. Secondly, after the jump to greater than 35 A., where it occurs, the expansion is continuous and independent of cation for monovalent cations. In this region the montmorillonite is probably developing a diffuse double layer and behaving as a colloid[7]. The swelling is then essentially osmotic and is expected to be independent of cation for ions of the same valence.

The sudden jump in spacing from about 20 A. to about 40 A. is interesting and is probably associated with reversal of the force due to the charge on the montmorillonite sheets. At low spacings the force will be electrostatic and attractive, as in mica, whereas at high spacings the charge will result in a repulsive (osmotic) force[8].

At high spacings this repulsive force is presumably balanced by van der Waals – London attractive forces[7].

For the swelling to pass from the first to the second region the hydration energy of the monovalent interlayer cations must be sufficient to expand the spacing to about 20 A., that is, to overcome the electrostatic attraction. The hydration energy of the large monovalent cations is insufficient to overcome this potential barrier, so that when collapsed, montmorillonite saturated with these cations cannot expand beyond about 15 A. However, if this barrier is overcome by some other means, then the montmorillonite can continue to expand. This behaviour is consistent with the observation of Mattson[9], who noted that Sharkey soil colloid, a montmorillonite, swelled greatly when saturated with potassium ions but not after drying.

Why the divalent ions with their greater hydration energy do not cause greater expansion is not clear. However, several factors will contribute to limit their swelling. Because divalent ions have a much larger sphere of dielectric saturation, the electrostatic attractive forces between neighbouring montmorillonite sheets will not diminish as rapidly as they do for monovalent ions. In addition, the theory of Langmuir[8] indicates that the osmotic repulsive force will be much less for divalent ions, and montmorillonite sheets separated by large distances (greater than 25 A.) will collapse together if this force is insufficient to counterbalance the van der Waals attractive forces.

A full account of this work will be published elsewhere. It was carried out at Rothamsted Experimental Station, Harpenden, Herts, during the tenure of a C.S.I.R.O. (Australia) studentship.

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LETTERS TO THE EDITORS

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Temperature Distribution within the Earth's Core

In view of the recent article by Prof. F. E. Simon in *Nature* on the melting of iron at high pressures[1], it seems desirable to review the hypothesis I put forward to account for a solid inner core within the earth[2].

At the boundary between the silicate mantle and the iron core there must be a discontinuity in the melting-point – depth curve, although the actual temperature must be continuous across the boundary. The form of this discontinuity could, mathematically, take any of the three cases shown in Fig. 1. Case (i), in which the melting-point curve in the core is always above that in the mantle, is impossible; for the actual temperature curve must lie below the melting-point curve in the mantle, above the melting-point curve in the core, and yet be continuous across the boundary. Cases (ii) and (iii) are both possible. In case (ii), the melting-point curve in the core never rises above the value of the melting point in the mantle at the core boundary, and in case (iii) it exceeds this value for part of the core. If case (ii) is the truth, then as the earth cooled from a molten state, the entire core would be left liquid, whereas if case (iii) is the truth, then I have shown that a solid inner core would be formed[2]. As the earth cooled still more, the mantle would begin to solidify from the inside outwards, trapping a liquid layer between it and the now solid inner core. The above arguments can be modified if the earth were formed by the cold accretion of dust particles and afterwards heated up. If the earth became completely molten, its subsequent history would be the same as that already discussed. On the other hand, if the earth is still heating up, then either case (ii) or case (iii) could lead to a liquid core with a solid inner core.

However, most advocates of a cold origin for the earth consider the earth as relatively homogeneous at the beginning and to have differentiated as it heated up (see, for example, Urey[3]). The energy produced in the formation of the iron core, approximately 2×10^{38} ergs, would be released as heat near the core and would thus keep temperatures so high that a solid core would be impossible unless the earth had become entirely molten and all differentiation taken place, its subsequent history being the same as that of an earth with a hot origin. Finally, Rosenblatt[4] has considered the effect of a probable primeval endowment of uranium-236 and shown

Fig. 1. Possible forms of the melting-point – depth curve in the neighbourhood of the core boundary

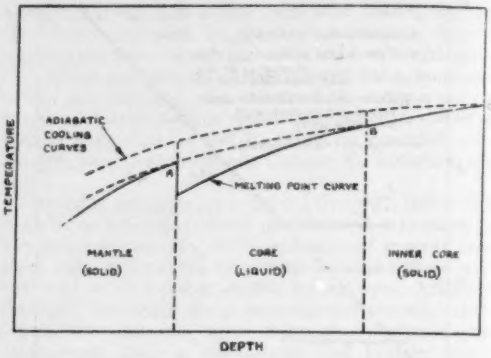

Fig. 2

that, owing to the relatively enormous disintegration-rate of this element, even a cold earth would have become completely molten. For these reasons, therefore, the rest of this communication is confined to the case of an earth cooling from a molten state.

Cases (ii) and (iii) can now be examined in the light of the work of Prof. Simon[1]. There are few data available on the melting point of silicates at the high pressures that prevail near the core boundary. The recent work of Uffen[5] based on seismic data and the theory of the solid state indicates that the melting point in the mantle at 2,900 km. is about 5,000° K. Unless there has been considerable cooling of the mantle, this would favour case (ii), that is, an all-liquid core, since the melting point of iron even at the centre of the earth is less than 4,100° K.[1]. However, such a large difference in the two melting points seems unlikely. The earlier work of Daly[6] gives a melting-point temperature of about 4,000° for the mantle at 2,900 km., which indicates that case (iii), that is, a solid inner core, is possible. Indeed, if this is the truth, as seems most likely from seismic evidence, it is possible to calculate the actual temperature at the core boundary by using the adiabatic temperature gradient curve for the core as obtained by me[7].

Since the boundary B of the inner core is the point of transition between the liquid and solid state in the core, the melting point at B must be the actual temperature at that level. Hence, by extending the adiabatic curve back from this point to A, the boundary between the core and mantle, we can obtain the actual temperature at A (see Fig. 2). The actual temperature at A must be less than the melting point of the silicates that compose the mantle and above the melting point of iron. Taking Prof. Simon's[1] value of the melting temperature at B as 3,900° K., the actual temperature at A is 3,600° K.

Finally, it is possible to obtain an upper limit for the melting point of the mantle at the core boundary by calculating the adiabatic curve that passes through C, the melting point at the centre of the earth. The melting-point curve of the mantle must be below this curve, or a solid inner core could not have formed. Prof. Simon's value for the melting point at C is 4,040° K., and this leads to the upper limit to the melting point of the mantle at 2,900 km. as 3,680° K. Prof. Simon places an upper limit of 4,380° K. for his temperature at C, and this in turn would raise

the upper limit to the melting point of the mantle at the core boundary to 4,000° K.

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Nov. 19.

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Recently, Simon[1] has presented a method of estimating the melting-point temperature of iron at high pressure. This is of considerable geophysical interest as it is frequently argued that the earth's core is composed of iron[2]. A method of estimating the melting-point temperature in the mantle had been proposed previously by Uffen[3]; but no reliable method of estimating this value in the core was then available. These two results are combined in Fig. 1, the dotted lines indicating our estimated limits of error. This curve is very similar to that given by Jacobs[4] in his qualitative explanation for the existence of a solid inner core to the earth. Furthermore, it provides an upper limit of 5,000° K. and a lower limit of 3,000° K. for the temperature at the core-mantle boundary. These two observations provide a basis for discussing the plausibility of some of the theories of the constitution and history of the earth's interior.

In Jacobs's explanation of the solid inner core, it is necessary to postulate a discontinuous decrease in the melting point at the mantle-core boundary. The quantitative results appear to support this hypothesis; but the melting point at the centre of the earth is considerably lower than at the bottom of the mantle. According to these data, solidification from a molten state would commence at the core boundary and progress outward. A much greater amount of cooling through the mantle than hitherto expected by the proponents of the cooling-earth hypothesis would be required before the adiabatic temperature curve for the core could meet the melting-point curve for the core. If it is assumed that this cooling has occurred, then solidification would have recommenced at the centre and progressed outward provided the melting-point gradient exceeded the adiabatic gradient. Jeffreys[5] has shown that cooling by conduction alone could scarcely have progressed below the melting point in the mantle to depths greater than about 700 km. at the present age of the earth. It seems imperative, then, if the curves given above are reasonably close to the truth, to assume that cooling has been by slow convection currents in the 'solid' mantle. The alternative is that the melting point of iron must be considerably revised upwards and/or the melting point at the bottom of the mantle must be revised downwards.

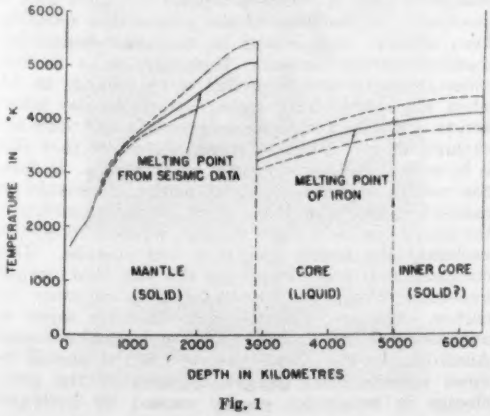

Fig. 1

As Simon has pointed out, the actual temperature at the boundary of the solid inner core would be the melting point of iron at that depth, since in the liquid part the actual temperature would be above the melting point while in the solid part it would be below the melting point. We might expect, then, that we could estimate the actual temperature in the liquid part of the core by computing the adiabatic gradient for this region and progressing outward from the 'known' temperature at the inner-core boundary. Vallé's[6] recent work, based on seismic data and theory of the solid state, gives $T_{5000}/T_{2900} = 1{\cdot}38$, which leads to a mean gradient of 0·51° K. per km. in the liquid core. This is greater than the mean melting-point gradient of 0·33° K. per km. for this region as given by Simon's data. It would mean that no inner core could form from a cooling earth and still leave a liquid outer core, nor could convection currents occur as required by the Bullard–Elsasser theory of the origin of the earth's magnetic field. Bullard[7] has estimated the mean adiabatic gradient in the liquid core to be 1·1° K. per km.; but his estimate was based on an assumed mean temperature of 10,000° K. Since the adiabatic temperature gradient is proportional to the temperature, Bullard's value reduces to 0·39° K. per km. if 3,500° K. is used instead of 10,000° K. This is still a little high, but could probably be reduced further by a more careful evaluation than was necessary for Bullard's calculations. With the data available at present, it is possible that convection currents would occur in the core as long as it is molten, and that the actual temperature lies close to Simon's melting curve.

The occurrence of a solid inner core may possibly be explained on the hypothesis of a cold origin for the earth with subsequent heating due to radioactivity. According to this hypothesis, the initial gradient would be essentially adiabatic with a temperature of about 2,000° K. at the mantle-core boundary[8]. Radioactive generation of heat, presumably concentrated near the earth's surface, would raise the temperatures so that the upper part of the mantle would melt[9]; the rising temperature in the interior would eventually meet the melting curve at the core boundary and melting would progress inward leaving a solid inner core. One would expect, however, that the actual temperature gradient in the liquid core would then be very small, if not reversed, so that convection currents could not arise. Furthermore, the layered nature of the earth would have to exist before melting began. This layering is more easily explained if the earth has passed through a molten stage.

The one conclusion we may draw with a fair degree of certainty and which depends on no particular theory of the earth's thermal history is that the actual temperature at the core boundary must lie

between the upper limit given by the melting point at the bottom of the solid mantle, and the lower limit given by the melting point at the top of the liquid core, that is, between 5,000° K. and 3,000° K.

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Fractionation of Isotopes by Distillation of some Organic Substances

In a recent communication having the above title, Baertschi, Kuhn and Kuhn[1] expressed surprise that substitution of carbon-13 for carbon-12 in the molecules $CHCl_3$, CCl_4, CH_3OH and C_6H_6 caused an enhancement of volatility, whereas substitution of chlorine-37 for chlorine-35 in the first two compounds, and of oxygen-18 for oxygen-16 in methanol, had the opposite effect. This led them to suggest that it might be a general rule for isotopic molecules containing a central atom that the molecular variety having the heavier isotope as central atom is more volatile than the isotopic molecule with the lighter central atom.

The purpose of this communication is to point out that these results can be understood on statistical thermodynamical grounds provided a plausible mechanism is assumed for intermolecular attraction in polyatomic molecules. It follows from the Sackur–Tetrode equation that the greater the mass of a molecule the greater is its translational entropy in the vapour, and therefore the greater is its probability of attaining the vapour state. (I wish to thank Prof. W. Kuhn and Dr. P. Baertschi for pointing out that the gas–mass–entropy effect will be compensated to some extent by the effect of mass on the entropy of the liquid.) A lucid explanation of this subtle connexion between volatility and molecular weight has been given by Sir Cyril Hinshelwood[2].

The entropy effect is, however, generally obscured by the over-riding influence of intermolecular attractions in the condensed phase, which normally increase with the size of the atom and with the number of atoms in the molecule. In consequence, greater molecular weight is usually associated with greater intermolecular attraction and lower volatility.

To explain the results of Kuhn *et al.*, it is necessary to postulate that intermolecular attraction is localized between nearest atoms of polyatomic molecules, and is not produced by the operation of central force fields between the molecules as units. In the case of carbon tetrachloride, it is clear that intermolecular attraction involving chlorine will predominate, since the carbon atoms are effectively screened. Thus isotopic replacement of carbon will mainly affect the entropy term, and the molecule containing the heavy isotope will be the more volatile. For isotopic replacement of chlorine, on the other hand, it appears that the change in the entropy term is overruled by the change in the intermolecular attraction term and heavy chlorine lowers the volatility.

In the case of isotopically different polyatomic molecules, the relative vapour pressures P_H/P_L (where P_H and P_L are the vapour pressures of the heavy and light species respectively) can generally be expressed as a function of temperature as follows:

$$\log \frac{P_H}{P_L} = \Delta a - \frac{\Delta b}{RT}.$$

Δa is usually positive because of the mass–entropy effect and favours the volatility of the heavier species. This tendency is opposed by Δb, which is positive and mainly reflects a difference $(\lambda_H - \lambda_L)$ in the latent heat terms due to the heavier species having the smaller zero-point energy of quasi-oscillation in the liquid.

Assuming that the relative vapour pressures of isotopic carbon tetrachlorides conform to the above equation, and using $(\Delta a)_C$, $(\Delta b)_C$, $(\Delta a)_{Cl}$ and $(\Delta b)_{Cl}$ to represent the appropriate terms for carbon and chlorine exchange respectively, it follows from experimental data of Kuhn *et al.* that at 308° K. $(\Delta a)_C > (\Delta b)_C/RT$ and $(\Delta b)_{Cl}/RT > (\Delta a)_{Cl}$. Since chlorine exchange involves double the mass change of carbon exchange, it is probable that $(\Delta a)_{Cl} > (\Delta a)_C$ and $(\Delta b)_{Cl} > (\Delta b)_C$. Although this will lead to $(P_H/P_L)_C \neq (P_H/P_L)_{Cl}$, it should not appreciably alter the temperature $T = \Delta b/\Delta a R$ at which 'crossing-over' occurs. Below this temperature, the lighter species is more volatile, while above it the order of volatility is reversed. To explain the experimental results, it is further suggested that the ratio $(\Delta b)_{Cl}/(\Delta a)_{Cl}$ exceeds the ratio $(\Delta b)_C/(\Delta a)_C$ because of stereochemical factors which control the nature of intermolecular attraction.

This idea, which will be reported in full elsewhere, involves the assumption that the total intermolecular attraction per molecule *in the liquid* is the sum of the interactions involving pairs of atoms from neighbouring molecules, and that each type of atomic interaction (for example, C...C; C...Cl; Cl...Cl) has a separate zero-point energy of quasi-oscillation. On this basis, isotopic replacement involving the atomic interaction with the greatest zero-point energy will have the greatest influence on Δb. In general, the type of interaction having the greatest energy will also have the greatest zero-point energy, and in the above example will be Cl...Cl, followed in order by C...Cl and C...C. Hence isotopic change of chlorine has a greater effect on Δb than a similar change in carbon. This postulate can thus give a qualitative explanation of the phenomena resulting from isotopic replacement in molecules containing shielded central atoms. Moreover, as a further consequence, it would predict a big change in Δb when any particularly strong intermolecular interaction is involved or when isotopes of small mass are exchanged, and it will be shown elsewhere that this is in accord with experimental observations. In fact, the results of Kuhn *et al.* on methanol provide an example of this behaviour. Thus, for carbon exchange the heavy species is more volatile, whereas in oxygen exchange the heavy species is less volatile. This comparison is complicated by the fact that oxygen exchange involves twice the change in mass for carbon exchange, but no such difficulty arises in comparing carbon exchange with hydrogen exchange. According to the above theory, CH_3OH should be more volatile than CH_3OD because of the great change in zero-point energy caused by hydrogen

exchange on the strong H...O interactions, and this is confirmed by the experimental results.

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Mechanism of the Bursting of Bubbles

The formation of drops, as the result of a gas or vapour bubble bursting at the surface of water, has been attributed to the break-up of the jet formed when liquid flows into the crater left by the burst bubble, and photographic evidence indicates that large drops are, in fact, formed in this way[1].

We have observed, however, that two separate mechanisms are involved in the bursting of a bubble—

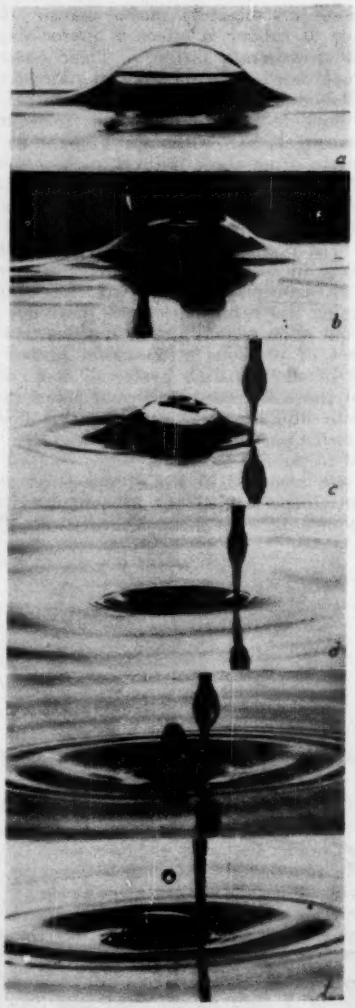

Fig. 1

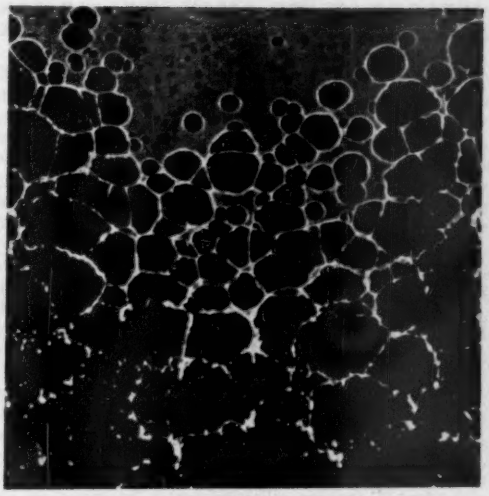

Fig. 2

one producing a cloud of droplets of diameter about 60 microns, and the other a few comparatively large drops of diameter about 1 mm. The various stages of the collapse are illustrated in Fig. 1, *a–f*. It will be observed that in the initial stage a protuberance develops on the hemispherical surface of the bubble, (*b*), the collapse of which produces the cloud of fine droplets and leaves a large gap in the bubble envelope (*c*). The escape of gas through this gap effectively disperses the cloud and imparts to the droplets a high velocity. Thereafter a crater is formed at the site of the bubble (*d*), and the incoming rush of liquid produces an unstable jet (*e*), which breaks up into one or more large drops (*f*).

Fig. 2 illustrates the way in which a thin film of liquid disintegrates to give the fine droplets observed in the initial stage of the burst.

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A Long Spacing at about 30 kX. confirmed from a Fireclay

The white clay from the Kurata Mine, Yamaguchi Prefecture, Japan, is largely composed of kaolinite; in flinty massive specimens it is commonly well crystallized, whereas in powdery massive specimens it is disordered. The clear resolution of the $(11\bar{1})$, $(1\bar{1}\bar{1})$ doublet is revealed in X-ray powder reflexions of a certain flinty specimen. The disordered behaviour is marked by a band of the two-dimensional type associated with (020). These facts were first reported by G. W. Brindley and K. Robinson for specimens from England. It is noteworthy in the present case that reflexions from the latter type are frequently accompanied by those of montmorillonite as well as a clear powder reflexion at 29·8 (± 0·5) kX. The basal reflexions of the montmorillonite are

14·7 (± 0·2) kX. (001), 4·93 kX. (003) and 2·97 kX. (005), and of the kaolinite, 7·13, kX. (001), 3·58 kX. (002) and 2·40 kX. (003). The intensity of the 14·7 line is commonly proportional to that of the 29·8 kX. line; but the ratio of the intensity of the kaolinite line to that of montmorillonite varies from specimen to specimen. The (060) spacing is 1·491, kX., which suggests that the amount of aluminium replacing silicon is small.

The reference specimens were ignited at temperatures of 300°, 500°, 700°, 900° and 1,100° C. for one hour and cooled and studied by X-rays immediately after cooling. The X-ray powder pattern was not affected by heating at 300° C. At 500° C., kaolinite lines as well as the 29·8 kX. line had disappeared; montmorillonite lines remained weak and unchanged except the 14·7 kX. line, which was replaced by a line at 11·7 (± 0·2) kX. The powder pattern at 700° C. agrees perfectly with that obtained at 500° C., that is, the 11·7 kX. line is persistent even at 700° C. At 900° C. most of the powder lines are just visible; mullite lines are revealed in the pattern obtained by heating at 1,100° C. Thus the usual 9·6 kX. line of dehydrated montmorillonite never appeared in the temperature range investigated.

Treatment with ethylene glycol caused the 14·7 kX. line to be replaced by a 15·6 (± 0·3) kX. line, and the 29·8 kX. line by a 32·3 (± 0·5) kX. line. Treatment with water expanded the 14·7 kX. spacing to 16 kX., and the 29·8 kX. spacing to 32–33 kX.

A specimen ignited at 700° C. was cooled and sealed in a glass tube immediately. At the beginning of the X-ray experiment, the specimen was transferred from the glass tube to a shallow cell on the slide glass containing phosphorus pentoxide to prevent adsorption of moisture into the specimen during X-radiation. Even with this treatment the 11·7 kX. line is still persistent at 700° C. To prevent the effect of exchangeable cations, the clay was electrodialysed and studied by X-rays at room temperature. The X-ray powder-pattern thus obtained agrees perfectly with that of the original specimen.

To account for these unusual X-ray properties, three types of lattices can be considered: (1) kaolinite; (2) the usual montmorillonite lattice with two sheets of water molecules (*M*-lattice), with a cell height of 15·4 kX., which is expected to decrease to 9·6 kX. by heating at least at 300° C., and to expand to 17·0 kX. with ethylene glycol treatment; (3) an unusual lattice (*G*-lattice) showing a configuration represented by a gibbsite layer interleaved between two adjacent silicate layers (pyrophyllite units); its cell height approximates to 14·0 kX., which is expected to be unaffected by the treatments with ethylene glycol and water, and may be persistent at least up to 700° C.

Thus it is considered that the 14·7 kX. line is caused by a mixed-layer structure containing the *M*-lattice and the *G*-lattice; this line is expected to expand to 15·6 kX., when the *M*-lattice expands to 17·0 kX. by treatment with ethylene glycol, and to decrease to 11·7 kX. when the *M*-lattice contracts to 9·6 kX. by dehydration. The long spacing of 29·8 kX. is considered to be caused by a super-lattice composed of these two lattices. It may be expected that the super-lattice will be completely destroyed at the same time as the *M*-lattice becomes dehydrated.

We are indebted to Prof. G. W. Brindley for discussion of this problem.

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Effect of Previous Stress-Strain History on the Dynamic Hysteresis Loop for Rubber in Compression

Several investigators have shown that the behaviour of rubber is affected appreciably by its previous stress-strain history. Their observations, in the main however, are based on indirect measurements of modulus and damping characteristics. Few, if any, have recorded stress-strain relationships in these investigations. Although it might be possible to calculate, from these indirect measurements, the slope and area of the dynamic hysteresis loop, such measurements give no indication of the position of the hysteresis loop relative to the axes of stress and strain. The position of the loop is of fundamental importance in assessing the dynamic characteristics of rubber, and plays a big part, for example, in determining the resilience of the material. To the best of our knowledge, little, or nothing, is known of the effect of previous stress-strain history on the position of the dynamic hysteresis loop, and it is felt that the test record presented below may be of immediate interest to workers in this field. The record forms part of a major investigation which it is hoped to publish later.

The test recorded in Fig. 1 consisted of several hysteresis loops carried out at constant frequency, each about a different mean deformation. The mean

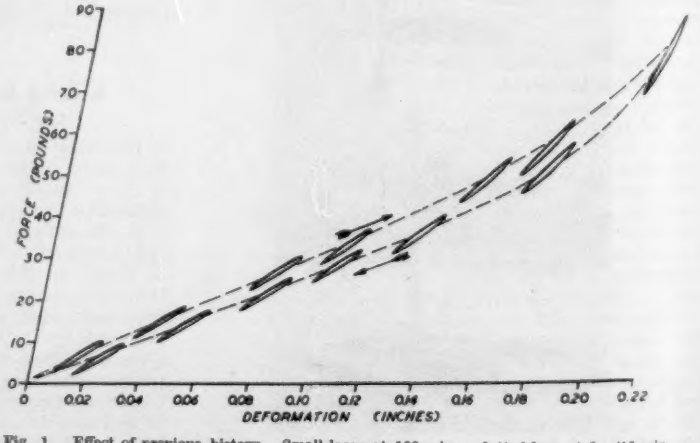

Fig. 1. Effect of previous history. Small loops at 100 c./s.; dotted loop at 1 c./15 min.

deformation was increased in increments up to a predetermined maximum, and then reduced to zero. It will be seen that the loops recorded on the 'return path' do not coincide with those on the 'outward path'. This difference persisted even when an interval of up to 30 min. was allowed after each adjustment of the mean deformation before recording the loop in question. The small hysteresis loops lie on the periphery of a larger loop which was recorded over the same range of deformation. This larger loop was performed very slowly—the rate being 1 cycle in 15 min. It would appear from these results that the so-called 'history effect' is but another manifestation of hysteresis.

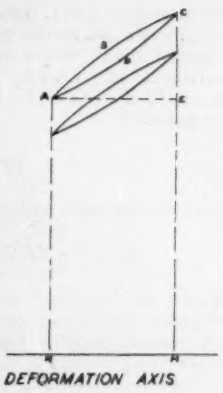

Fig. 2

The test was repeated with dynamic loops of larger amplitude from which measurements could be made of area and slope. No difference could be detected in either the areas or slopes of loops recorded at corresponding mean deformations over much of the outward and return paths.

The results presented here have a bearing on some previous observations concerning the terms resilience and percentage damping[1]. The term percentage damping—defined as the ratio of the loop area *ABCD* (Fig. 2) to the area *ABCE*—does not permit quantitative measurements to be made of the movement of the loop, since the line *AE* is not a fixed reference line but moves with the loop. The term resilience, on the other hand—defined for the upper loop as the ratio of area *NADCM* to *NABCM*—will theoretically permit a quantitative assessment to be made of the shift of the loop. In practice, however, since the areas involved are comparatively large and almost equal, the term resilience does not bring out the difference between the upper and lower loops. Therefore, before any quantitative work can be attempted on the effect of stress-strain history, the definition of some suitable means of measuring the effect must be agreed upon.

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Regularities in the *F*-Region of the Ionosphere

The variation of the maximum ionization density ($N_{max}F_2$) of the F_2-region of the ionosphere is known generally to depart widely from the $\sqrt{\cos\chi}$ law of Chapman (where χ is the zenith distance of the sun). It has, however, been recently shown by Ratcliffe[1] that if, instead of $N_{max}F_2$, the total ion content (per unit cross-section) of the F_2-region (n_TF_2) be considered, the variations of the total ion content with $\sqrt{\cos\chi}$ appear to be more regular. I have followed up this view[2], and have shown that if, in place of n_TF_2, the total ion content of the F_1- and F_2-region as a whole (n_T) is considered, then the variations of n_T with $\sqrt{\cos\chi}$ become very much more regular. However, it was observed that on these otherwise regular variation curves (diurnal and seasonal) certain abnormal peaks are superposed. I had provisionally explained these as due to the effects of solar tides, superposing themselves on the variations due to changes in the zenithal position of the sun. In order to check this assumption seasonal variation curves of the monthly mean values of the 24-hr. average total ion content ($\bar{n}_T$) were plotted (Figs. 1 *a*, *b*, *c*). These seasonal variation curves—from which the solar tidal effects are obviously eliminated—are found to closely follow the corresponding $\cos\chi$ curves, justifying the assumptions made. The data analysed were for the same three stations—Slough, Falkland Islands and Singapore—as had been studied in the earlier work.

These results also support the recent hypothesis[2] that the F_1- and F_2-regions are formed by a common ionizing process (ionization of oxygen at its first ionization potential), and that in the single bank of ionization so formed there is produced, besides the

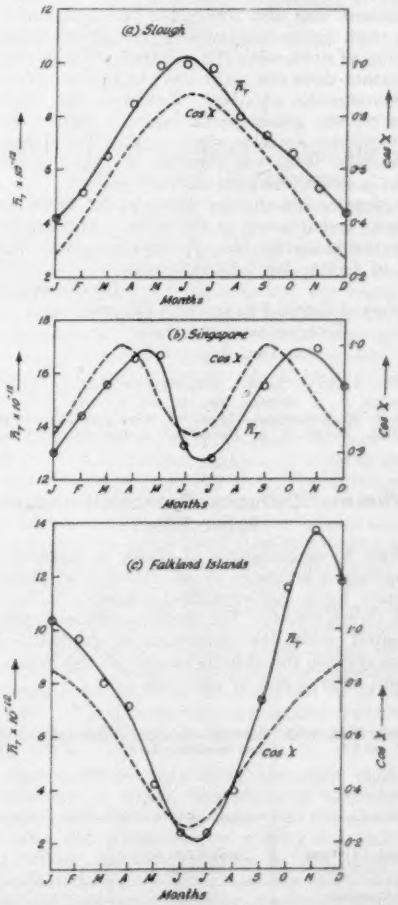

Fig. 1. Seasonal variation curves of the monthly mean values of $\bar{n}_T$ and $\cos\chi$ in 1951 (χ is the noon-time zenith angle of the sun)

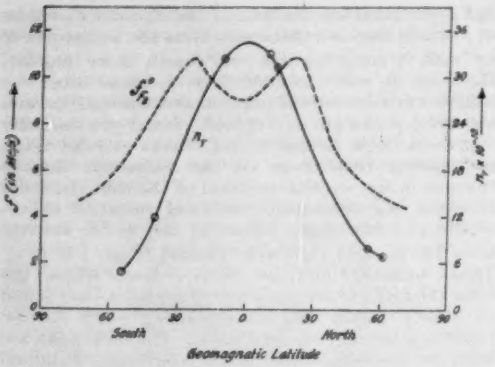

Fig. 2. Variation with latitude of the monthly mean noon values of f^0F_2 and n_T for April 1952

usual Chapman maximum F_1, a secondary maximum F_2 higher up, due to the peculiar physical characteristics of the region above F_1-maximum.

An interesting fact regarding the latitudinal variation of the monthly mean values of noon-time total ion content was also noticed. The curve in Fig. 2 shows that, unlike the curve depicting the latitudinal variation of noon-time f^0F_2 (dotted), that of the total ion content does not show the 'Appleton dip' around the geomagnetic equator. However, the maximum occurs on the geomagnetic equator rather than on the geographic equator, showing that the distribution of even the total ion content of the F_1- and F_2-regions is subject to geomagnetic control.

My thanks are due to Prof. S. K. Mitra for his guidance and interest in the work. Thanks are also due to the Scientific Man-Power Committee, Government of India, for financial help.

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Thermal Diffusion Potentials and the Soret Effect

When a temperature gradient is applied to a homogeneous solution of an electrolyte, there is a tendency for a concentration gradient to be established (Soret effect). The thermal diffusion potential associated with the temperature gradient should change during the establishment of the Soret equilibrium. For a cell of the type:

Reversible electrode A at T^0	Solution containing ions reversible to A	Reversible electrode A at $T + \Delta T^0$

the change in e.m.f. during the establishment of this equilibrium can be calculated theoretically[1–3]. In the simplest case[3], where the solution contains a uni-univalent salt obeying the ideal law, the change in e.m.f., Δ_t, for a cell containing electrodes reversible to anions is

$$\Delta_t = -2RT/F.\, n_+\, \mathrm{d}/\mathrm{d}T\, (\ln m)\,; \qquad (1)$$

and, for one with cation-reversible electrodes,

$$\Delta_t = +2RT/F.\, n_-\, \mathrm{d}/\mathrm{d}T\, (\ln m)\,; \qquad (2)$$

where an increase in concentration at the hot electrode is taken as positive, and n_+ and n_- represent the transference numbers of the cation and anion respectively.

Conditions suitable for the establishment of the Soret effect are not easily attained, and earlier experiments[2] designed to provide a test of the above equations were only partially successful. The difficulty of verifying these equations, though not of determining Soret coefficients, may be overcome by a modification of the technique used in this laboratory for the measurement of thermoelectric e.m.f. values at the time of the establishment of the thermal gradient[2]. Using cells of substantially the same design as those used previously, we have measured the e.m.f. ($\Delta\varphi$) of the cell:

Ag	$AgNO_3$, molality $m - \Delta m/2$, at T^0	$AgNO_3$, molality $m + \Delta m/2$, at $T + \Delta T^0$	Ag

and compared it with that found for an identical system with a solution of molality m in contact with both electrodes. The results obtained in the two cases so far examined are shown in Table 1.

The mean temperature in these experiments was approximately 29° C. The values of $\mathrm{d}\varphi/\mathrm{d}T$ for a cell with no concentration gradient were obtained by interpolation from the results of independent experiments[4].

The experimental values have the sign predicted by equation (2) and, in the second case, the numerical agreement is excellent. In the first, the discrepancy between the observed and the calculated value is considerably greater than the experimental error in the e.m.f. measurements, and the experimental value requires confirmation.

Clearly, this method permits the investigation of deviations from the ideal equations shown above, and suggests a new method of investigating the Soret effect. An empirical knowledge of the relation Δ_t and $\mathrm{d}/\mathrm{d}T$ $(\ln m)$ would enable Soret coefficients to be calculated from measurements of Δ_t in cells in which the Soret equilibrium is established between plane parallel electrodes the surface temperature of which is known accurately. This method is not limited to the rather high concentrations employed in earlier work in this field[3], and measurements in

Table 1

m (mol./1,000 gm. solution)	Δm (mol./1,000 gm. solution)	ΔT (° C.)	$\mathrm{d}\varphi/\mathrm{d}T$ (μ volt/° C.)	$1/m.\Delta m/\Delta T \times 10^3$	Δ_t (exp.) (μ volt/° C.)	Δ_t (calc.) (μ volt/° C.)
0·009948	Zero	—	− 609	− 1·0	− 71	− 28
0·009948	− 0·000044	4·40	− 680			
0·009928	Zero	—	− 609	− 21·1	− 595	− 589
0·009928	− 0·000915	4·36	− 1,204			

dilute solutions should prove of considerable interest in the theoretical interpretation of the Soret effect.

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Anhydrous Hydrogen Fluoride as a Solvent for Proteins

Anhydrous hydrogen fluoride (m.p., − 83° C.; b.p., 19·5° C.) has been found to be a powerful solvent for a wide variety of proteins. Experiments were carried out in transparent tubes moulded or machined from polychlorotrifluoroethylene polymer; these tubes containing the intensively dried protein samples could be attached to a metal vacuum system, hydrogen fluoride added by distillation, and direct visual observations made in the absence of moisture. Among proteins which are readily soluble in hydrogen fluoride at 0° are ribonuclease, lysozyme, pepsin, trypsin, crystallized egg albumin, bovine plasma albumin, bovine plasma globulin, edestin, peanut protein globulin, casein, zein, silk fibroin, hide collagen, insulin and adrenocorticotrophic hormone. These are all soluble at least to the extent of 20 mgm. per ml., and much more concentrated solutions can in general easily be prepared. Thus, a solution containing 350 mgm. per ml. bovine plasma albumin is still quite fluid at 0° C. The solutions are clear, colourless to faint amber, and are very much less viscous than corresponding aqueous solutions. The globular proteins dissolve rapidly even at − 78° C., whereas silk fibroin and hide collagen undergo strong swelling and require many hours at room temperature for complete solution.

The iron-containing proteins cytochrome *c*, catalase and hæmoglobin are very soluble in hydrogen fluoride. They give pink solutions which have absorption spectra very similar to those exhibited in water. The ability of metal-complex compounds to exist in hydrogen fluoride appears to be a general phenomenon, for it is found that metal phthalocyanines, cobalt(III)amine-complex compounds, and a considerable variety of other metal-complex compounds dissolve in hydrogen fluoride without precipitation of metal fluoride.

Proteins were recovered by evaporation of the solutions on the vacuum line. Films of recovered silk fibroin and collagen gave characteristic polypeptide infra-red spectra. Of the proteins mentioned above, ribonuclease, lysozyme, trypsin, cytochrome *c*, hæmoglobin, hide collagen, insulin and adrenocorticotrophic hormone are recovered in a water-soluble state after remaining in hydrogen fluoride solution for 2 hr. at 0° C. Recovered insulin was found by bioassay on mice to have retained 80 per cent of its initial activity, and similarly adrenocorticotrophic hormone was recovered intact with full retention of its original biological activity. The biological properties of the other water-soluble proteins after recovery remain to be examined. The surprising retention of biological activity by insulin and adrenocorticotrophic hormone after dissolution and recovery from hydrogen fluoride solution suggests that this solvent may have real significance in protein studies.

Because of its low freezing point, liquid hydrogen fluoride may be an interesting medium for carrying out chemical reactions on proteins at very low temperatures. For example, it has been observed that ozone, which appears to be quite soluble in hydrogen fluoride, changes a pink hæmoglobin solution to green. Hydrogen peroxide solutions in hydrogen fluoride (prepared by addition of the 1 : 1 urea–hydrogen peroxide addition compound) change the pink colour of cytochrome *c* and catalase solutions to yellow. Trioxane, which has been found to be highly soluble in hydrogen fluoride, gives a typical formaldehyde reaction when added to a protein dissolved in hydrogen fluoride; the viscosity of the solution increases until a rigid gel results. These and other characteristic protein reactions with many of the usual protein reagents can thus be carried out at much lower temperatures than has been possible in aqueous systems.

Details of these experiments will appear elsewhere.

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Formation of a Mixed Disulphide of Cysteine and Glutathione

In our studies on the synthesis of glutathione by *Saccharomyces cerevisiae*, the yeast was incubated in 0·01 *M* potassium dihydrogen phosphate with cysteine containing sulphur-35. Samples of the mixture were removed at intervals and the component amino-acids and peptides were separated by paper chromatography. The chromatograms were sprayed with a ninhydrin solution and autoradiograms of the chromatograms were made on Kodak No-screen X-ray film.

When a phenol–water mixture was used for preparing a descending chromatogram, a spot which contained a considerable amount of sulphur-35 was observed. This substance ($R_F = 0{\cdot}27$) was intermediate between glutathione disulphide ($R_F = 0{\cdot}16$) and cystine ($R_F = 0{\cdot}42$). It was found in largest amounts in the mixture of yeast and sulphur-35 cysteine immediately after the cysteine had been added to the yeast and before it had been metabolized by the cells to any extent. Since both cysteine and glutathione are oxidized to the disulphides during chromatography under our conditions, it seemed possible that the new substance was a mixed disulphide of cysteine and glutathione formed not by the yeast but by oxidation by the air. The intermediate compound was shown, indeed, to be a disulphide by the use of Toennies's reagent[1].

Further evidence supporting the view that this compound was a mixed disulphide of cysteine and glutathione and that it was formed in the absence of yeast cells was obtained by mixing cysteine and glutathione in aqueous solution in the absence of yeast cells and also by using cysteine or glutathione labelled with radioactive sulphur. A solution of sulphur-35 cysteine was mixed with non-labelled glutathione in the absence of yeast cells, and this mixture was chromatographed immediately after being prepared.

Again three substances which reacted with ninhydrin and which had the R_F values mentioned above were found. Cystine and the intermediate spot were shown by an autoradiograph of the paper chromatogram to contain sulphur-35, while the glutathione disulphide spot did not. By counting the filter paper chromatogram with a thin end-window Geiger–Müller tube, it was found that 30 per cent of the sulphur-35 cysteine was incorporated into the intermediate compound when the initial solution contained equimolar amounts of sulphur-35 cysteine and glutathione.

A similar experiment was carried out with glutathione containing sulphur-35 and non-labelled cysteine. When the sulphur-35 glutathione and cysteine were mixed in solution and the mixture chromatographed, the intermediate disulphide spot again appeared. This substance and glutathione disulphide were shown to be radioactive whereas the cysteine spot was not. It was concluded, therefore, that this material was most probably a mixed disulphide of cysteine and glutathione:

γ—Glu.(CyS).Gly
|
(Cys).

Wikberg[2] has reported the formation of a mixed disulphide of glutathione and cysteinylglycine when glutathione was partially hydrolysed. His mixed disulphide was separated by paper electrophoresis from cystine and glutathione disulphide. He also reported the preparation of a mixed disulphide of cysteine and glutathione by oxidation with perhydrol at *p*H 7·5.

The results reported here were discussed before the American Chemical Society Meeting at Los Angeles in March 1953.

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A Method for the Cleavage of 2,4-Dinitrophenylhydrazones and its Application to Steroidal Ketones

2,4-Dinitrophenylhydrazones have proved very useful derivatives for identification purposes, but have so far found only limited application in preparative work. This is due to the fact that there exists no general method for the regeneration of the corresponding carbonyl compounds. As Djerassi pointed out[1], the failure to cleave 2,4-dinitrophenylhydrazones has imposed considerable limitations on the use of the Mattox–Kendall[2] dehydrobromination method in the field of sterol chemistry. Thus, in the case of 2,4-dinitrophenylhydrazones of $\Delta^{4,6}$-dien-3-ketosteroids, only about 5–10 per cent of ketone could be recovered after treatment with pyruvic acid and hydrobromic acid, and derivatives of $\Delta^{1,4}$-dien-3-ketosteroids could not be split at all[1].

We have now found that the splitting of these 2,4-dinitrophenylhydrazones can be achieved in good yields by the following general procedure, the quantities and times required for saturated-, Δ^1-, and Δ^4-3-ketosteroids being denoted by (*a*), and those for $\Delta^{1,4}$- and $\Delta^{4,6}$-3-ketosteroids by (*b*). The 2,4-dinitrophenylhydrazone (1 gm.) is dissolved in acetone (*a*, 200 c.c.; *b*, 500 c.c.) containing concentrated hydrochloric acid (*a*, 5 c.c.; *b*, 10–20 c.c.) and the solution is refluxed (*a*, 45 min.; *b*, 7–8 hr.); this displacement can also be brought about at ordinary temperature for 2,4-dinitrophenylhydrazones of class (*a*) (24 hr.) and for the more soluble derivatives of class (*b*) (15 days). The yellow to orange-yellow solution is slightly cooled and treated with stannous chloride (5 gm.) dissolved in concentrated hydrochloric acid (20 c.c.). Water (*a*, 30 c.c.; *b*, 80 c.c.) is added and the mixture heated to reflux in an atmosphere of nitrogen for 45 min.; further heating decreases the yield and purity of the ketone recovered. With 2,4-dinitrophenylhydrazones of both classes, this reduction can be carried out at ordinary temperature (24 hr.). The acetone is distilled off under reduced pressure at room temperature, the residue extracted with benzene, and the organic layer washed with 1 *N* hydrochloric acid until no more coloured material is removed. The benzene solution is finally washed with water and evaporated. The recovered ketone is purified by the usual methods.

Using this procedure the following results were obtained with approximately 1 gm. each of 2,4-dinitrophenylhydrazones:

(1) *Cholestan-3-one*: yield, 98 per cent (m.p., 127–128°; litt., 129–130°).
(2) Δ^4-*Cholesten-3-one*: yield, 95 per cent (m.p., 78–79·5°; litt., 80·5°).
(3) Δ^1-*Cholesten-3-one*: yield, 84 per cent (m.p., 99–100° (from dil. alcohol); litt., 98–100°).
(4) *Testosterone*: yield, 98 per cent (m.p., 148–150°; litt., 152°).
(5) *Progesterone* (*bis* 2,4-dinitrophenylhydrazone): yield, 86 per cent (m.p., 120° (from pet. eth.); litt., 121°).
(6) $\Delta^{1,4}$-*Cholestadien-3-one*: yield, 83 per cent (m.p., 110–111°; litt., 112°).
(7) $\Delta^{4,6}$-*Cholestadien-3-one*: yield, 88 per cent.
(8) Methyl $\Delta^{1,4}$-3-ketoetiocholadienate: yield, 67 per cent (m.p., 152–153°; litt., 156°).

As it is somewhat difficult to purify $\Delta^{4,6}$-cholestadien-3-one on a small scale, the yield was determined by reconverting it into the corresponding 2,4-dinitrophenylhydrazone (m.p. 234° from acetic acid).

The successful cleavage of the $\Delta^{1,4}$-dien-3-one derivatives supports Djerassi's assumption that they are true hydrazones and not pyrazoline derivatives (cf. ref. 1, footnote 19, p. 1005).

The final benzene solution of methyl $\Delta^{1,4}$-3-ketoetiocholadienate was extracted with sodium bicarbonate solution. On acidification this gave 110 mgm. of an acid (m.p. 277–280° with dec.), showing that partial hydrolysis of the ester group had occurred.

Other ketones, such as dibenzyl acetone, have also been recovered successfully by this treatment.

We suggest that the method is of wider application and that it may be useful in other fields of preparative organic chemistry.

We wish to express our thanks to Dr. Carl Djerassi, to the CIBA, S.A. (Basle) and to the Schering A.G. (Berlin) for gifts of specimens which have greatly facilitated this work. Full details of this investigation, including improvements in the preparation and purification of some 2,4-dinitrophenylhydrazones of 3-ketosteroids, will be published in the *Bull. Soc. Chim. Belg.*

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Formation of Acetyl Phosphate by the Action of X-Rays on Monoethyl Phosphoric Acid in Aqueous Solution

Our earlier work on the chemical action of X-rays on the nucleic acids in aqueous systems[1] has led us to suggest that labile compounds, including labile phosphate esters, are formed on irradiation, and that these may play some part in the breakdown of the polynucleotides. Following some observations on the effects of the radiation on relatively simple phosphate esters (for example, glycerophosphates, phosphoglyceric acid), we have suggested that, in general, oxidative attack at a $>CH(OH)$ (secondary alcohol) group by the free radicals can lead to the formation of a $>C=O$ (carbonyl) group, and that, if the latter is α- or β- to a phosphate group, a more or less labile ester is produced[2].

In order to elucidate further the chemical mechanism by which labile phosphate esters are formed in these circumstances, a systematic investigation of the effects of X-rays on a number of phosphate esters has been undertaken.

We are now reporting some observations on one of the simplest phosphate esters, namely, monoethyl phosphoric acid. Here one might expect that oxidative attack by the radicals on the primary phosphoryl group ($-CH_2OPO(OH)_2$) would lead, by a relatively straightforward process, to the corresponding aldehyde, together with inorganic phosphate. On the other hand, we may apply, in the presence of oxygen, a mechanism which we have recently found to be operative in the attack on certain simple aliphatic compounds[3]; this involves reaction of the organic radical primarily formed with molecular oxygen, which can lead to an organic hydroperoxide.

In the case of monoethyl phosphoric acid, the hydroperoxide resulting from attack on the primary phosphoryl group would have structure (I), subsequent decomposition of which could lead to acetyl phosphate (II):

$$\underset{\text{(I)}}{CH_3CH(O_2H).O.PO(OH)_2} \xrightarrow{(-H_2O)} \underset{\text{(II)}}{CH_3CO.O.PO(OH)_2}.$$

We have now demonstrated that this latter mechanism does, in fact, also hold for this system, since we have been able to show that irradiation of monoethyl phosphoric acid with X-rays in the presence of oxygen gives acetyl phosphate, among other products. This conclusion is based on the following experimental evidence.

(i) Slow liberation of inorganic phosphate after irradiation.

(ii) A positive Lipmann reaction[4] for acetyl phosphate, namely, formation of the corresponding hydroxamic acid which gave the characteristic ferric salt in acid solution (ferric acethydroxamate was identified by its absorption spectrum).

(iii) A difference in the yields of inorganic phosphate as determined separately by the methods of Lowry and Lopez[5] and Berenblum and Chain[6]; whereas the former is suitable for the determination of inorganic phosphate in the presence of acetyl phosphate[5], under the conditions of the Berenblum–Chain procedure, it is known that acetyl phosphate is rapidly hydrolysed[7].

A typical experiment was as follows: 100 ml. of a solution of monoethyl phosphoric acid (0·1 per cent calcium salt), adjusted to *p*H 5·5 and saturated with oxygen (1 atm.), were irradiated with X-rays (200 kV.) with a total dose of 7×10^4 r. (integral dose-rate = 2,340 r./min.). Under these conditions, 15 μmoles of acetyl phosphate per 100 ml. were produced. At the same time, some acetaldehyde was formed and about 5 μmoles of inorganic phosphate; somewhat more inorganic phosphate than acetaldehyde is to be expected, owing to the slight decomposition of the acetyl phosphate during irradiation.

These results show that one of the major processes occurring under these conditions is that leading to acetyl phosphate. In agreement with the mechanism outlined above, we have found that the formation of acetyl phosphate requires the presence of molecular oxygen.

These observations would suggest that certain other compounds containing the primary phosphoryl group ($-CH_2OPO(OH)_2$) may give, on irradiation in the presence of oxygen, the corresponding acyl phosphate to a smaller or greater extent.

Thus, labilization of organic phosphate esters can be due to the production of carbonyl groups (α- or β- to the phosphate) and/or, under certain conditions, to the formation of acyl phosphates. Carbonyl groups can be produced by OH radicals (generated by the action of the ionizing radiation on water, namely, $H_2O \rightsquigarrow H + OH$), and their formation is therefore not dependent upon the presence of oxygen in solution, although, for reasons discussed previously[2,3], oxygen should, in general, enhance the yield of the carbonyl compound. On the other hand, for the formation of the acyl phosphate, as described above, the presence of molecular oxygen is essential.

This appears to be the first instance in which acetyl phosphate is formed by a relatively simple oxidation process in aqueous solution.

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A Trough for Paper Chromatography consisting of Segments

The sensitivity of paper chromatography is such that lack of reproducibility often hampers the systematic approach. In order to facilitate measurements under identical conditions, we are using a glass trough which consists of four equal segments.

Each segment can hold duplicate strips of paper of 7 cm. × 40 cm., or one can apply two sheets of paper of 40 cm. × 40 cm. if three small cuts are made on the top edge (see Fig. 1). To mark the movement of liquid flowing from one segment, 1 c.c. of

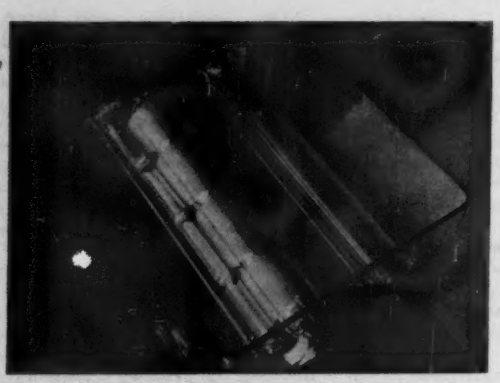

Fig. 1. Apparatus for descending paper chromatography with a trough consisting of four segments

10^{-4} *M* quinine sulphate is added to segments 1 and 3; after the paper has been dried, fluorescence shows clearly the borders of the solvents flowing from each segment. If the position of the trough is exactly horizontal, these borders are found to be perfectly vertical to the axis of the trough. We can thus establish a *p*H gradient on a paper, when each segment contains a buffered solvent system of a slightly different *p*H. When this technique is applied to protein hydrolysates as a second run (first run with propanol/water 7 : 3), it is possible to accelerate or to slow down the movement of amino-acids with polar groups; in many instances incomplete separation can be overcome.

The following example demonstrates the effect of a variation of the ionic strength of the buffer system on the separation of arginine, lysine and glutamic acid. The solvent system *m*-cresol/phenol 1 : 1 was used as described by Levy and Chung[1]; 0·1 *M* potassium dihydrogen phosphate/0·05 *M* sodium borate of *p*H 9·0 and of varying ionic strength was added as buffer. The run lasted for 17 hr. at 18° on Whatman No. 1 paper. One paper of 40 cm. × 40 cm. was used, and at the end it was cut into four equal strips for photography. The colour was developed with ninhydrin according to the method of Moore and Stein[2].

Besides the R_F-values, we give in Table 1 the planimeter value of the areas of the spots. We are using the latter as a measure of the compactness of spots; but we do not consider them to allow a quantitative evaluation of single amino-acids as has been suggested elsewhere.

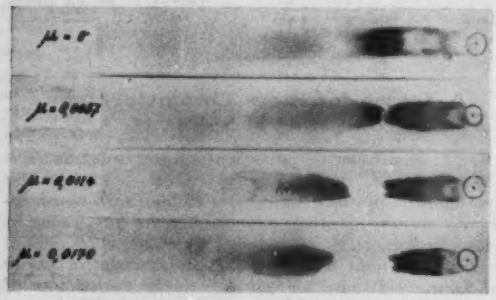

Fig. 2. One-dimensional chromatograms showing the influence of an increase of the ionic strength of the borate buffer on the same paper under identical conditions

Table 1

	Ionic strength of borate buffer							
μ	0·0000		0·0057		0·0114		0·0170	
	R_F	Pl*	R_F	Pl*	R_F	Pl*	R_F	Pl*
Arginine	0·37		0·33	1·00	0·34	0·41	0·37	0·30
Lysine	not sep.		0·21	0·17	0·28	0·15	0·30	0·13
Glutamic acid			0·14	0·53	0·13	0·46	0·10	0·37

* Planimeter reading.

Thus an increasing ionic strength of the borate buffer leads to an improved separation of basic and acidic amino-acids, as well as to more compact spots.

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Bicarbonate Content of the Blastocyst Fluid and Carbonic Anhydrase in the Pregnant Rabbit Uterus

It has been noted in the course of a chemical investigation of the properties of rabbit blastocysts that the fluid which fills the cavity of the blastocyst at six and seven days after mating turns distinctly alkaline after withdrawal and standing in air for a few moments, whereas at eight days, in similar circumstances, the reaction of the fluid remains practically unaltered, at *p*H 7·8[1]. In view of the low buffering capacity of the fluid obtained from six- and seven-day old blastocysts, it was thought likely that bicarbonate may be responsible for the shift in the *p*H value. Accordingly, manometric determinations were carried out in samples of fluid from blastocysts at six, seven and eight days after mating, collected by means of a technique described elsewhere[1].

The results of the manometric experiments have justified our assumption: a remarkably high content of bicarbonate, three times that present in maternal serum, was found in the unimplanted six-day old blastocysts; at seven days, when the majority of the blastocysts are in the process of incipient implantation, it was less, but there was still a considerable amount of bicarbonate in the fluid: on the other hand, at eight days, when implantation is complete, the level of bicarbonate was somewhat below that recorded for maternal blood (Fig. 1). As a matter of interest, it may be added here that we have also examined the bicarbonate content in cow ovarian follicle fluid from early luteal phases[2], and in cow and pig allantoic and amniotic fluids (at twenty-nine and twenty days of pregnancy, respectively); except for the pig allantoic fluid, which at that stage appeared to lack bicarbonate, the other fluids exhibited bicarbonate values close to those found in blood plasma.

The occurrence of bicarbonate in a high concentration in the early blastocysts has led us to investigate the presence of carbonic anhydrase in the uterus. The uterine mucosa was collected from thoroughly bled six- and seven-day pregnant does, and also from non-pregnant rabbits, and assays of carbonic anhydrase activity were carried out in saline-phosphate extracts from the mucosa, by means of the colorimetric[3] and boat[4] methods. It was found that the

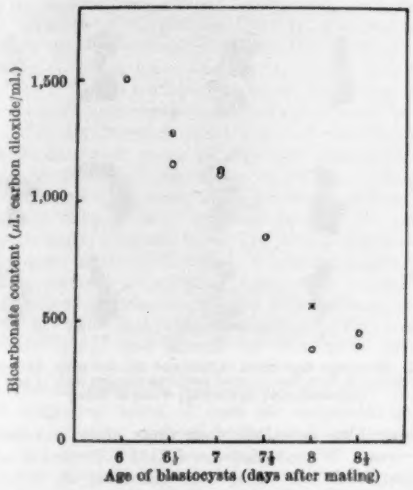

Fig. 1. Bicarbonate content in the rabbit blastocyst fluid: o, blastocyst fluid; ×, maternal serum

non-pregnant uterine mucosa possessed practically no carbonic anhydrase activity; the extracts made from the mucosa of the pregnant uteri, however, invariably showed strong carbonic anhydrase activity which could be completely inhibited by low concentrations of sulphanilamide, the specific inhibitor of this enzyme[5]; the residual blood in the uterine extracts accounted for not more than a tenth to a twentieth of the total enzymic activity inherent in the mucous membrane.

It is too early to speculate on the mechanism of bicarbonate formation in the early blastocysts, and on the role of carbonic anhydrase in the pregnant uterus. However, by way of commentary, we should like to recall briefly certain facts which may well have some bearing upon our observations. Concerning first the presence of bicarbonate in the rapidly growing blastocysts, it is significant that the requirement for bicarbonate, and also for phosphate ions, in synthetic media for embryonic cells proliferating in tissue cultures has repeatedly been stressed of late[6,7]. While, however, the inner cell mass of the rabbit blastocysts obviously has at its disposal an ample supply of bicarbonate, the total phosphorus content of whole six-day-old blastocysts was found to be not more than 2·5–2·8 mgm. per cent. Next, with reference to the occurrence of carbonic anhydrase in the female reproductive tract, it is noteworthy that some time ago its presence was reported[8] in the uterine epithelium of egg-laying hens. Lastly, certain observations of Meldrum and Roughton[9] may also be relevant to our findings; these authors have observed that early fœtal goat blood contained but traces of carbonic anhydrase, and that even towards the end of gestation fœtal blood still possessed only 10 per cent of the activity of maternal blood; furthermore, a similar deficiency in carbonic anhydrase is known to exist in chicken embryos[10].

Efforts are being made to extend to other species the present study on the distribution of uterine carbonic anhydrase throughout the entire period of pregnancy, in an endeavour to establish the physiological significance of this enzyme for the developing embryo; it is hoped that at the same time a clue may be found to account for the high content of bicarbonate in the early blastocysts.

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Ruminant-like Digestion in a Marsupial

With very few exceptions, animals do not produce an alimentary cellulase; consequently cellulose, which may constitute a considerable proportion of the diet of herbivores under many environmental conditions, is made available as a nutrient only by the fermentative activities of the microbial population of the alimentary tract. In most mammals this occurs in the cæcum and colon, where the material is delayed long enough for effective fermentation. Their digestive physiology is nevertheless characterized by the absorption of glucose. This is the main metabolic fuel and is found in high concentration in the blood, a much reduced level resulting in coma.

The contrasting digestive physiology of ruminants has been extensively investigated in recent years. Ingested food passes directly to the rumen where a considerable quantity of the cellulose, as well as the other more soluble carbohydrates, undergoes fermentation resulting in a mixture of fatty acids[1] along with carbon dioxide and methane. Favourable growth conditions for the rumen microbial population are maintained by the copious alkaline salivary secretion. This pregastric fermentation means that little or no glucose-yielding materials are presented for absorption from the intestines. This is reflected in a much lower blood-glucose level in ruminants (35·5 mgm. per cent)[2] than in non-ruminants (80 mgm. per cent). Of the volatile fatty acids absorbed from the rumen and large intestines[3], part are gluconeogenic, as most of the circulating acid is acetic acid, which has a glucose-sparing action in the tissues[4]. Consistent with this, very low blood-glucose levels after insulin treatment are well tolerated[5].

The experiments on the macropod marsupial (*Setonix brachyurus*) reported briefly here were initiated as a result of three unrelated observations: (*a*) dissections showed that the stomach was comparatively large, sacculated in the upper regions and possessed a well-defined œsophageal groove; (*b*) unconfirmed reports of cud-chewing in kangaroos; and (*c*) the finding, in connexion with studies of adrenal functions[6], that the normal low blood-sugar could be lowered still further by insulin treatment without overt deleterious effect.

A ruminant-like digestion was thus suggested, and microscopical observation on stomach contents con-

firmed the presence of a rich microbial population similar to, but rather simpler than, that of the sheep. No ciliates have been observed; but this may be due to the diet. The digestibility of the cellulose has not been assessed, but extensive microbial erosion of this material within the stomach has been observed. The steam-volatile acids produced in the upper stomach are almost completely absorbed by the time the ingesta reaches the fundus. The *p*H of the upper stomach varies between 4·6 and 8·0, according to the activities of the micro-organisms and the level of fatty acids (range 15–2 *M*/mol. per cent). The identity of the volatile acids has not been investigated, nor the source of alkali to the upper stomach.

Blood drawn from the aorta, the venæ cavæ, hepatic-portal vein and the hepatic vein confirm the relatively low blood-sugar status of the animal, and show clearly that the fatty acids produced in the stomach and cæcum are absorbed into the portal vein. Some of these acids are removed in the liver, and comparison of arterial values and venous returns demonstrate clearly that fatty acid is removed by the tissues. These experiments will be reported fully elsewhere.

These findings are of interest on two counts. (1) It is generally held that the evolutionary lines emerging from therapsid reptiles and leading to marsupials and eutheria have been separate since the Cretaceous. This means that the ruminant type of digestion has been developed independently in marsupial macropods and eutherian ruminants. It is therefore a new and compelling example of parallel (or convergent) evolution. (2) *Setonix*, domesticated and averaging only 2–3 kgm., promises to be a cheap and fruitful tool for metabolic studies parallel to those on domestic ruminants.

The marsupial-holding pens were erected with funds from the Commonwealth Research Grants to the University; salary and expenses for G. Sharman were from a Nuffield grant.

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Sept. 24.

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Intravital Staining in Titrations of Group *B* Coxsackie Viruses in Weaned Mice

Group *B* Coxsackie viruses have been shown to be capable of producing a severe pancreatitis in weanling and adult mice[1]. Necrosis of pancreatic acinar tissue occurs within a few days of infection and involves a high proportion of the cells in affected areas. These observations, together with the affinity of necrotic tissue for acid intravital dyes, have been utilized in the development of a technique for the rapid titration of pancreatotropic group *B* strains in weaned mice. Briefly, the technique is as follows.

The mice used in the titrations are injected intraperitoneally with 0·5 ml. of a 0·5 per cent solution of trypan blue in saline, four days after inoculation with virus. When mice are killed four hours after injection with the dye, the pancreas in infected animals is found to be stained intensely (Fig. 1). In most cases intense dark blue staining of a large part of the pancreas is found, and in the remainder, lighter blue areas of varying size are seen. Staining may be demonstrated from two days after inoculation with virus, and increases rapidly in intensity. Maximum intensity of staining is reached within four days, and is retained for several days. These results were obtained by investigation of the influence of virus dosage and time on the degree of staining, and showed that the most suitable (shortest) time between inoculation with virus and injection with dye in titrations is four days.

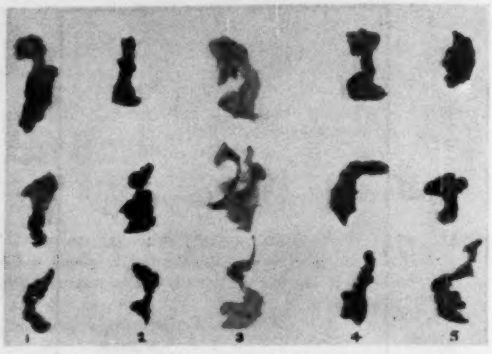

Fig. 1. Pancreatic staining in normal and infected mice. Infected pancreas stains deep blue, normal pancreas remains pink. 1 and 2, Connecticut 5; 3, normal; 4 and 5, Nancy

In the accompanying table, results of five parallel titrations in mice 21–24 days old of a single pool of a Group *B* strain (Adelaide 1) by two methods are presented. The 'conventional' LD50 and ID50 titres were calculated by the method of Reed and Muench[2] from the number of deaths which occurred within three weeks and the number of survivors which had suffered fat replacement of pancreatic acinar tissue.

The titre determined by the intravital staining technique was found to agree closely with the LD50 titre; the 'conventional' ID50 titre was slightly higher. The latter observation suggests that, in a small proportion of infected mice, pancreatic necrosis is not revealed by intravital staining, either as a result of delayed development of the lesion when the inoculum is small, or because not all centres of necrosis involve the surface of the pancreas.

In further experiments the technique has been shown to be suitable for use in neutralization tests, since neutralization indices of sera estimated by the above technique and by LD50 estimations agreed closely.

Comparison of Titres of a Group *B* Virus by Two Techniques

Titration number	Conventional technique		Intra-vital staining technique
	LD50	ID50	ID50
1	4·75*	5·32	4·83
2	5·17	5·50	5·37
3	4·68	5·17	4·67
4	5·68	5·84	5·37
5	4·83	4·83	4·75
Mean	5·02	5·33	5·00
Standard deviation	0·41	0·38	0·34

* Titres are expressed as their negative logarithms.

The techniques almost universally adopted for the titration of Coxsackie viruses, and for the detection of neutralizing antibodies against them, employ suckling mice inoculated within a few days of birth[3]. When suckling mice are used, non-specific deaths and cannibalism of sick mice are relatively common. In Group *B* infections with pancreatotropic strains, the main signs of infection (cachexia, weakness and cyanosis) may also be seen in mice dying from non-specific causes. Also, maintenance of an adequate supply of litters may be difficult, particularly in small laboratories. The technique described overcomes many difficulties by allowing the use of weaned instead of suckling mice; by reducing the time taken in titrations from three weeks to four days—in itself desirable—accommodation problems are alleviated, and much of the time normally spent in the daily examination of mice is saved. The method would be particularly valuable in large-scale screening tests of sera for neutralizing antibodies, and is at present being used successfully in this laboratory for that purpose.

To date the technique has been successfully applied to three Group *B* strains, namely, Connecticut 5, Nancy, and Adelaide 1, representing three serological types. Although pathogenicity of Group *B* strains for weaned and adult mice has not been widely reported, Dalldorf[4] has recently presented evidence that this may be due to differences in the methods used for virus passage rather than to differences in susceptibility of different mouse strains. The technique may therefore be more widely applicable than at first appeared possible. A more detailed account of this work will be published elsewhere.

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Oct. 7.

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Chromosome Number of Human Endometrium

The determination of chromosome number in human somatic tissues has been the cause of controversy from time to time. Recently, Timonen[1] made an extensive study on the variations of the chromosome number in the human endometrium in the proliferative stage. From a study of one thousand nuclei, he finds that the highest frequency distribution is between 21 and 25 chromosomes. This result has been criticized by Sachs[2]; the number obtained by him from the same tissue of human beings and from other mammals corresponds to the diploid number of the particular species concerned.

For some time past, I have been studying the chromosome number in human endometrium and also in the epithelial cells of the cervix uteri both in normal and in malignant conditions. The present communication is based on the study of the chromosomes of the human endometrium in the proliferative stage.

Human endometrial tissue immediately after removal was cut into small pieces and was transferred to 0·002 – 0·005 *M* oxyquinoline solution[3] for 2 hr. at 16° C., after which it was fixed either in acetic alcohol for Feulgen squash or was subjected to the acetic–carmine technique. As a result of the pretreatment, the chromosomes are more or less straightened, and the centromeric region and the split between the chromatids of the individual chromosome are exaggerated (Fig. 1). Squashing may also cause cellular damage, as pointed out by Sachs[2]. Doubtful cases have therefore been avoided so far as practicable.

Fig. 1. Metaphase chromosomes of human endometrium. (× 1,000)

The chromosome number counted in the different cells of my material varies from 30 to 59 chromosomes (Fig. 2). Of 75 nuclei counted, 15 had 48 chromosomes and 37 had chromosome numbers ranging from 40 to 47; of the latter, 33 nuclei had 40–45 chromosomes. Twenty nuclei had chromosomes ranging from 30 to 39, of which 14 had 36–39 chromosomes. Three nuclei had 54, 55 and 59 chromosomes respectively. My observations, therefore, support Timonen's conclusion regarding the variability of the chromosome numbers between different cells, but the range and characteristics of variation observed by him are not found in my material. My unpublished observations on the chromosome numbers in human uterine cervix tissue also support Timonen's conclusion regarding the variability of chromosome numbers in human somatic tissue.

Thus, it now appears fairly certain that the chromosome numbers vary widely between different cells of the same tissue as well as between different tissues, not only in human beings but also in other mammals. That this is due to the presence of mitotic abnormalities such as lagging, non-disjunction, multipolar spindle, etc., in the tissue is also clear. Admittedly, human tissue is difficult material for chromosome counts; but the differences in results reported by Timonen, Sachs and myself can scarcely be due to technique alone. There must be some other real source of variation which would account for the differences. It seems to me that two factors may play an important part in the production of a particular frequency distribution of chromosome

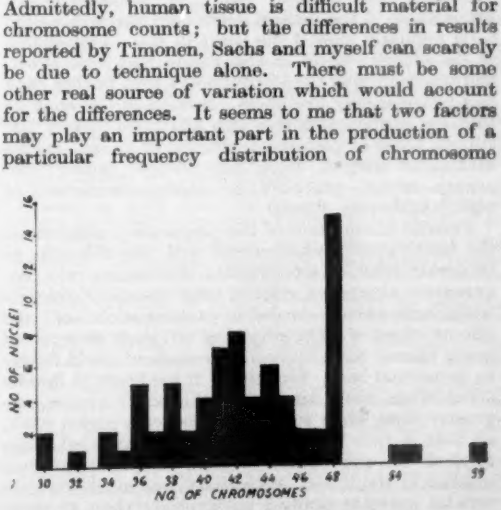

Fig. 2. Frequency distribution of chromosome numbers

number in a particular tissue. They are: (i) mitotic age of the tissue; and (ii) frequency of mitotic abnormalities originally present in the tissue. Gopal-Ayengar[3] has reported a very significant observation which supports this hypothesis. He finds, in his study of transplanted tumours in several strains of mice and rats and in the Chinese and golden hamsters, that the cell population of early transplanted generations of tumours are almost entirely diploid, whereas later transplants have diploid, triploid and intermediate types exhibiting a gradual shift to tetraploidy.

I am indebted to Dr. Subodh Mitra, director of the Chittaranjan Cancer Hospital, Calcutta, for providing laboratory facilities and for his interest, and to Dr. S. P. Ray-Chaudhuri, of the University of Calcutta, for his guidance during the course of investigation.

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Oct. 2.

[1] Timonen, S., *Acta Obst. et Gynec. Scandinav.*, **31**, Supp. 2, 1 (1950).
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Physiology of the Heart of *Asellus aquaticus* L.

Work on this subject was carried out some years ago, on nearly three hundred intact individuals and heart preparations, the latter consisting of heart, pericardium and dorsal body-wall of the thoracic region. The heart-rate of an average (10 mm.) individual at summer temperature was 180–200 per min., but heart-beat was interrupted for short periods, for example, at the onset of a burst of locomotor activity. Dissection of the preparation always slowed and sometimes arrested the beat for periods up to 30 min. On recovery, the beat was regular and incessant, often at the maximal normal rate.

Mechanical and electrical stimulation revealed an accelerator nerve following the anterior aorta, undoubtedly the anterior nerve of Alexandrowicz[1]. Transection of the ventral nerve cord just behind the head regularly slowed the heart *in situ*. Transection of the anterior aorta in this region had little effect, and transection of the ventral nerve cord farther back had progressively less effect. Section of the anterior thoracic segmental nerves also had little effect; but cutting those of posterior segments, or damage to the abdominal ganglia, often (not always) caused temporary arrest—probably an injury-stimulation of cardio-inhibitory fibres.

Faradic stimulation of the preparation accelerated the beat, which synchronized with the stimulus at moderate rates of acceleration. Increasing rate progressively shortened systole, until complete diastolic 'amplitude-arrest'—probably tetanization of the dilator muscles[2]. On switching off, such an arrested heart passed back through the stage of rapid flutter to its normal beat. Sensitivity of the heart to faradic stimulation when applied in the aortic region was greater than when applied in the heart region itself, so that a rate of stimulation which arrested when applied in the former region, accelerated when applied in the latter. Sensitivity was much lower to faradic currents applied transversely than to those along the heart.

Relatively light pressure, localized or diffuse, to the ventral face of the floor of the pericardium caused arrest, its duration proportional to intensity of stimulation; a local reflex inhibition seems indicated. Moderate traction dorsalwards of the roof of the pericardium (that is, the body-wall) usually accelerated the heart-rate, and the volume of the pericardium may be the critical factor. Excessive traction inhibited heart-beat.

Asynchrony between the two ends of the heart was observed after transection of the dorsal heart-wall[3], and often in moribund preparations. Sometimes asynchrony between the lateral halves was observed; on occasion one half, longitudinal or lateral, was completely quiescent. Complete asynchrony of all muscle fibres—the 'bag of worms' type of fibrillation—was produced by excess sodium chloride and possibly by other conditions. Activity of aortic valves and ostia showed some independence of that of the myocardium, as expected from their innervation[1]; but in recovery from arrest, activity often began in the ostia and spread to the myocardium.

The optimal concentration of sodium chloride for survival appeared to be 0·6 per cent, that is, lower than that used by Kawaguti[4] for *A. nipponensis*. Preparations survived up to 48 hours in 0·6 per cent sodium chloride, 0·02 per cent potassium chloride, 0·02 per cent calcium chloride, 0·02 per cent sodium bicarbonate, and 0·2 per cent glucose. Excess calcium and deficit of potassium ions slowed or arrested the heart in diastole. Excess potassium ions accelerated, with diastolic amplitude-arrest as the limit; exoskeletal calcium ions probably prevented effective calcium-deficit, and calcium-free Ringer's solution had little effect. Magnesium, beryllium and hydrogen ions slowed, to arrest in diastole. Acetyl-choline accelerated in relatively high concentration[5]. Adrenalin had no consistent effect. Inhibition by the animal's own digestive fluid[3] was confirmed; mammalian lipase and trypsin similarly inhibited.

The curve relating temperature centigrade (T) (changed gradually) to beat-interval (t), that is, to the reciprocal of rate, was approximately a rectangular hyperbola $(t + a)\ (T + b) = c$, where a, b, c are constants. Thus there was an upper limiting rate and a lower limiting temperature, a 'physiological zero', at which the beat virtually ceased. This varied between + 4° and − 4° C. (obtained by supercooling), in different individuals, but was usually below 0° C. Maximal rate was attained at 25–35° C., that is, again variable between individuals; above this temperature there were irregularities and slowing of the beat. Since a was small (less than 0·5 sec.) a virtually linear relationship between rate and T was often obtained, and it follows also that $(\log t)/\{\log (T + b)\}$ was virtually linear. Preparations frozen by seeding the supercooled medium recovered their beat on thawing.

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Oct. 17.

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FORTHCOMING EVENTS

(Meetings marked with an asterisk • are open to the public)

Monday, February 8

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Lord Rennell of Rodd: "Aids to the Domesday Geography of N.W. Hereford".

UNIVERSITY OF LONDON (at the Imperial College of Science and Technology, Royal School of Mines, Prince Consort Road, London, S.W.7), at 5 p.m.—Prof. A. Kantrowitz (Cornell): "Physics of Shock Waves".• (Further Lectures on February 9, 22 and 23.)

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. F. E. Zeuner: "The Domestication of Animals by Early Man: its Psychological and Social Aspects".

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. C. Fromageot (Paris): "The Metabolism of Sulphur Amino-Acids and the Cycle of Sulphur in Nature".• (Further Lectures on February 11 and 15.)

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (joint meeting with the AGRICULTURE GROUP, at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Dr. E. M. Crowther: "The Production and Use of Fertilizers—Some Current Trends and Problems" (Jubilee Memorial Lecture).

Tuesday, February 9

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. Lord Stamp: "The Action of Bacterial Enzymes on Immunizing Antigens".• (Eighth of fifteen Lectures on "The Scientific Basis of Medicine".

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. N. P. Inglis: "Non-Ferrous Metals for the Chemical Engineer".

PRESENTATION OF TECHNICAL INFORMATION DISCUSSION GROUP (in the Mechanical Lecture Theatre, Department of Electrical Engineering, University College London, Gower Street, London, W.C.1), at 6 p.m.—Mr. J. Kennedy: "The Making of a Book—The Author and his Printer".

SOCIETY FOR ANALYTICAL CHEMISTRY, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

Wednesday, February 10

SOCIETY OF CHEMICAL INDUSTRY, FOOD AND MICROBIOLOGY GROUPS (at the Low Temperature Research Station, Downing Street, Cambridge), at 2.15 p.m.—Symposium on "The Preservation of Food with Ionizing Radiations".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. J. A. Saxton: "Basic Ground-Wave Propagation Characteristics in the 50–800 Mc./s. Band"; Dr. J. A. Saxton and Mr. B. N. Harden: "Ground-Wave Field Strength Surveys at 100 and 600 Mc./s.".

TELEVISION SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 7 p.m.—Mr. G. G. Gouriet: "Colour Television" (The Fleming Memorial Lecture, Part 1). (Further Lecture on February 24.)

RADAR ASSOCIATION (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 7.30 p.m.—Mr. K. E. Harris: "Some Unsolved Radar Problems".•

Thursday, February 11

ROYAL SANITARY INSTITUTE (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Discussion on "Heat Treatment of Milk within the Bottle", opened by Prof. E. L. Crossley.

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. R. D. Keynes: "The Ionic Fluxes in Frog Muscle"; Mr. G. S. Christie and Mr. J. D. Judah: "Mechanism of Action of Carbon Tetrachloride on Liver Cells".

BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. H. B. Maitland: "Anti-Virus Immunity".• (Ninth of fifteen Lectures on "The Scientific Basis of Medicine".)

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1), at 6 p.m.—Dr. D. Williams: "Recent Developments in the Structural Approach to Aeroelastic Problems".

UNIVERSITY OF LONDON (at Wye College, near Ashford, Kent), at 8.15 p.m.—Mr. E. M. Nicholson: "The Nature Conservancy".•

Friday, February 12

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Anniversary Meeting; Annual General Meeting.

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Third Report of the Pipe Flanges Research Committee, presented by Dr. A. E. Johnson.

ASLIB (at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. C. W. Hanson and Mr. C. E. C. Hewetson: "Journal Circulation: An Enquiry into the Practice".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. C. Keith Simpson: "Science in Crime Detection".

Saturday, February 13

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting with the ASSOCIATION OF CLINICAL BIOCHEMISTS, S.E. and S.W. REGION, in the Department of Zoology, The University, Reading), at 2.30 p.m.—Papers and Demonstrations on "Physical Methods in Biochemistry".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR SCIENTIFIC OFFICER (with first- or second-class honours degree in chemistry or a biological subject, or approved equivalent professional qualifications, and at least three years postgraduate or other approved experience), and an EXPERIMENTAL OFFICER (with a degree in an approved scientific subject, or equivalent professional qualifications), in the Combined Scientific Development and Forensic Science Department of the Ministry of Commerce—The Secretary, Civil Service Commission, Stormont, Belfast (February 12).

SENIOR TECHNICIAN (with knowledge of E.H.T. and pulse circuits for Geiger and scintillation counting) for maintenance and development of electronic equipment—The Secretary, Board of Governors, Hammersmith Hospital and Postgraduate Medical School, Du Cane Road, London, W.12 (February 13).

LECTURER (with qualifications in cytology, genetics and plant breeding, and with teaching and research experience in these subjects) IN BOTANY—The Secretary, The University, Aberdeen (February 15).

LECTURER (with a degree or a recognized diploma in mining) IN THE DEPARTMENT OF MINING AND GEOLOGY, and a LECTURER (with an honours degree in physics, and preferably with teaching, industrial, or research experience) IN PHYSICS—The Principal, Wigan and District Mining and Technical College, Wigan (February 15).

ASSISTANT LECTURER IN THE DEPARTMENT OF CHEMISTRY, and an ASSISTANT LECTURER IN THE DEPARTMENT OF PHYSICS—The Secretary, Bedford College, Regent's Park, London, N.W.1 (February 19).

SENIOR PHYSICIST (with an honours degree in physics, and five years previous experience in hospital physics or research, and preferably with a practical knowledge of radio-elements)—The Secretary, Lambeth Group Hospital Management Committee, Renfrew Road, London, S.E.11 (February 19).

ASSISTANT LECTURER (with special qualifications in physical chemistry or in physical organic chemistry) IN THE DEPARTMENT OF CHEMISTRY—The Registrar, University College of South Wales and Monmouth, Cathays Park, Cardiff (February 20).

ASSISTANT LECTURER IN CHEMISTRY—The Registrar, University College, Singleton Park, Swansea (February 27).

CRIPPS CHAIR OF METALLURGY—The Registrar, The University, Nottingham (March 1).

PROFESSOR OF PHYSIOLOGY at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, March 1).

UNIVERSITY DEMONSTRATOR IN AGRICULTURAL ZOOLOGY AND PHYSIOLOGY OF FARM ANIMALS, a UNIVERSITY DEMONSTRATOR IN SOIL SCIENCE, a UNIVERSITY LECTURER IN AGRICULTURAL ZOOLOGY AND PHYSIOLOGY OF FARM ANIMALS, and a UNIVERSITY DEMONSTRATOR IN AGRICULTURAL BOTANY—The Secretary, School of Agriculture, Downing Street, Cambridge (March 5).

ASSISTANT LECTURER IN PHYSICS, and an ASSISTANT LECTURER IN THEORETICAL PHYSICS—The Registrar, King's College, Strand, London, W.C.2 (March 6).

CHAIR OF GEOGRAPHY—The Registrar, University College, Leicester (March 6).

LECTURER IN CHEMISTRY, a DEMONSTRATOR IN BIOCHEMISTRY, and a DEMONSTRATOR IN CHEMISTRY, in the Department of Biochemistry and Chemistry—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (March 6).

LECTURER (with an honours degree in mechanical engineering, and special experience of mechanical engineering drawing and design, theory of machines and strength of materials) IN MECHANICAL ENGINEERING, at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, March 7).

LECTURER IN PHILOSOPHY at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Johannesburg, March 31).

I.C.I. RESEARCH FELLOWSHIPS IN PHYSICS, CHEMISTRY, BIOCHEMISTRY, ENGINEERING, METALLURGY, PHARMACOLOGY, CHEMOTHERAPY, or related subjects—The Secretary General of the Faculties, The Old Schools, Cambridge (April 30).

TURNER AND NEWALL RESEARCH FELLOWSHIPS for research in ENGINEERING, INORGANIC CHEMISTRY, PHYSICS, and allied subjects—The Registrar, The University, Manchester 13 (April 30).

JUNIOR LECTURER IN THE DEPARTMENT OF ENTOMOLOGY—The Assistant Dean, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1 (June 1).

AGRICULTURAL OFFICER (with a degree or diploma in agriculture or allied subjects), at Dunholme Field Station, near Lincoln, for duties which will include organizing field experiments, and assisting with research work on sugar beet—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

CHAIR OF EDUCATION—The Registrar, The University, Sheffield.

DIRECTOR OF THE BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY, to take charge of the administration of the Institute, and to conduct and supervise research—The President, Governing Body of the Palaeobotanical Society, Birbal Sahni Institute of Palaeobotany, Lucknow, U.P., India.